CHEMICAL & METALLURGICAL ENGINEERING

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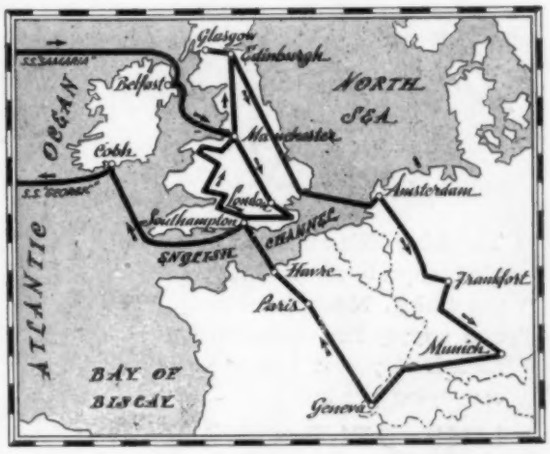

So we go to Europe again. This time to check and compare American progress with that abroad, to attend the International Chemical Engineering Congress in London, June 22-27, the joint tour with the British Institution of Chemical Engineers, and the annual meeting of the Society of Chemical Industry in Liverpool, July 6-10, followed by a brief trip to chemical centers in Holland, Germany, Switzerland and France.

As background against which to picture these important meetings and industrial developments, **Chem. & Met.** publishes next month a special International Chemical Engineering Number. Among its distinguished contributors are leading chemical engineers and industrialists of the major chemical countries of the world. As an additional feature there will be 8 pages of valuable maps reproduced in color on special paper stock. If you want an extra copy, better reserve it now!

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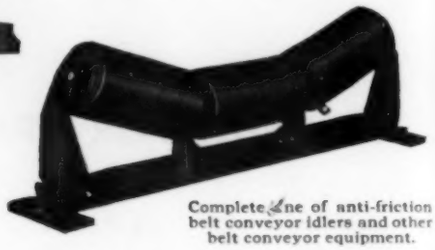

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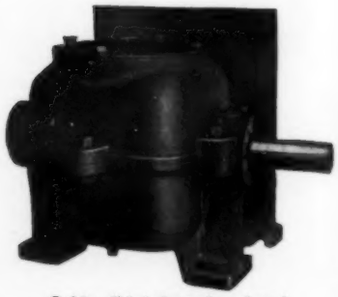

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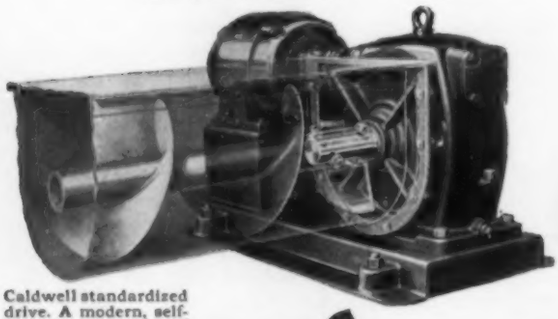

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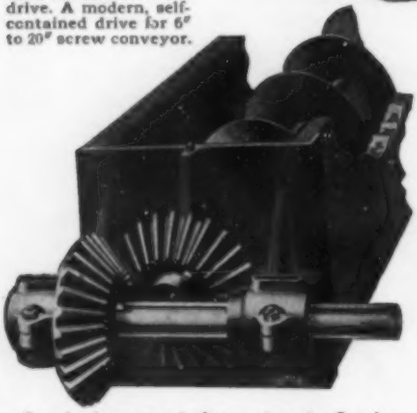
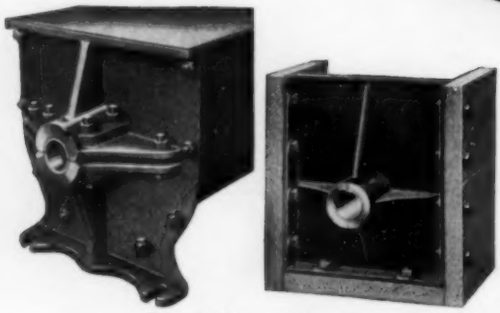


Standard countershaft trough ends. Can be furnished for wood or steel trough.



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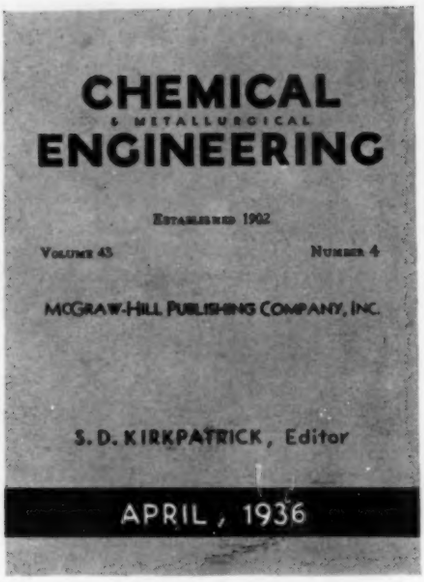


CHEMICAL INDUSTRIES CARRY ON

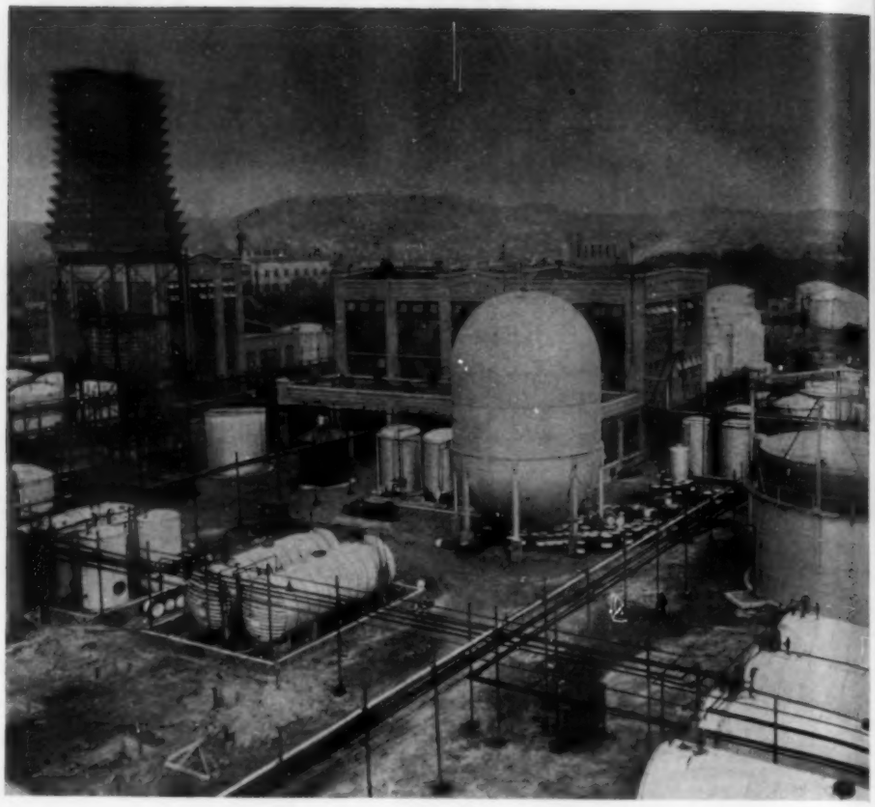
● LATE last month as the flood waters of Pennsylvania, Ohio and New England gradually receded, many chemical engineers in process industries faced the discouraging task of salvaging and rehabilitating plants and equipment. Fortunately, the physical losses were seldom as severe as the feverish headlines would lead one to believe. Industrial equipment can be rehabilitated —often economically replaced by more modern machinery—but if there is a spread of disease, these great floods can do irreparable damage.

One thing which the newspapers did not exaggerate—but rather overlooked or took for granted—was the tremendously important contribution which chemical industry and the chemical and engineering professions made to protect the lives of millions of people residing in the stricken areas. Without our present highly efficient means for sterilizing water supplies and controlling dangerous sources of stream pollution, ghastly epidemics would certainly have followed in the wake of the floods. Without necessary medicinals and drugs, thousands might have perished. Chemical and pharmaceutical manufacturers were well aware of their responsibilities in this emergency and many organizations worked night and day in rushing supplies of bleaching powder, chlorine, and medicinals to the health departments that needed them so badly.

Many are the stories of heroic service that perhaps will never be told, because they are but normal routine in chemical industry's relations to the community. How one Pennsylvania plant succeeded in protecting its own water supply and then shut down its manufacturing operations in order to distribute drinking water in its acid carboys to the stranded citizens in the surrounding town. How textile plants in Providence shared their bleaching powder with New England waterworks. How commandeered trucks from Niagara Falls and Newark rushed emergency shipments of hypochlorite and vaccines to the Williamsport and Lewisburg areas, where typhoid epidemics were threatening. How experienced engineers of the Bureau of Mines station in Pittsburgh contributed unique safety service in the detection of flammable, explosive and poisonous gases. These and many more chapters should some day be written into chemical history.

But in the meantime we should also take a more positive and constructive lesson from these recurring series of great disasters. If floods have become a recognized industry in the United States, periodically menacing life and property, it is our own fault if we do not do something about them. That preventive measures are possible and practicable has been demonstrated. Here then is the place for a public-works program more vitally essential than building additional hydro-electric plants in the Tennessee Valley or the Pacific Northwest. Here too is a challenge for engineers to prove their worth in better plant location, design, and construction. Chemical industry stands to gain more from a well-planned offensive than from any emergency rôle of defense against such forces of death and destruction.

FROM AN EDITORIAL VIEWPOINT



»Census Confusion Delays Returns

DESIRABLE cooperation between the Census Bureau and the Bureau of Mines was organized in order to simplify and to speed up the inquiries of both bureaus. Unfortunately, some confusion has resulted in the minds of industrial executives.

Asked to fill out new forms of questionnaires, these business men have been accusing the Bureau of Mines of attempting greatly to enlarge its authority. That charge is wholly unwarranted. The Bureau well deserves the prompt cooperation and complete reporting on all details of the questionnaire. The only result will be a more reliable interpretation of the returns, because they will be handled by technically well-informed persons rather than merely by statistically minded clerks. All individual returns will be held strictly confidential, just as in the past.

It is to be hoped that any firms which have not yet reported on the "Mines and Quarries" inquiry will do so promptly. Delay would be particularly unfortunate for process industries with respect to such commodities and raw materials as asbestos, antimony, bauxite, fluorspar, sulphur and a score of other non-metallics as well as metals.

»Who Are the Real Advocates of Inflation?

WASHINGTON is now worrying more about boom problems and the threat of speculative orgies than about the Townsend plan and congressional schemes for currency inflation. This interesting change of economic front has in it an equally interesting sidelight on human nature. The Townsend plan fell into disrepute in Washington only when it appeared that the plan leaders got large emoluments for their "charitable efforts." Economic absurdity did not remove the issue from politics, but

the suggestion of graft promptly did. The ghost is not dead, but has withdrawn into the shadows for this season at least and in all likelihood forever.

One wonders whether or not some of the inflation momentum has not also been lost for a very similar reason. It is freely charged about Washington that the real backers of inflation, working behind the smoke screen of noisy congressional spokesmen, were themselves speculating in such a manner as to gain by any enactments of Congress. Rumor also has it that some high-power investigators got the facts about these folks and laid much of the dust that would otherwise have further confused congressional debates and political stump meetings this Summer and Fall.

»Go Forth and Spread the Gospel!

"EVERY business man should memorize the definition of the three functions of industrial research as stated by Dr. C. E. K. Mees, director of research of the Eastman Kodak Company and repeat it every day of his active life: 'To discover new processes and products; to discover ways of making a better product and to discover more economical ways of making existing products.'"

These words of fundamental gospel in the chemical engineering creed have just been "discovered" in an address of a banker, speaking before a group of business men in Philadelphia. This research-minded banker, Fred W. Shibley of Bankers Trust puts the shoe on the other foot. For years the late Dr. Arthur D. Little and others patiently plead with bankers and financial directors for a true appreciation of the purposes and value of research in industry. That even one should have learned so well as to go forth as a missionary is most heartening. His excellent "sermon" published in full in the December, 1930, issue of *The Plan* of Philadelphia, can be read with great benefit, even by the most research-minded executive in process industry.

»A Paper Boom in the South

THIRTY years ago with the introduction of the kraft process the South first became a factor in the manufacturing of paper. Since then the industry has expanded rapidly in the southern states, and at the present time a vast program of new construction is under way in Georgia, Arkansas, Florida and Texas. Plant sites and wood reserves have recently been acquired by eastern and western paper interests; and it is reported that plans for additional mills will soon be announced. This expansion is due not only to the vast area of forest land that is capable of supplying tremendous quantities of pulpwood, but also to the relative accessibility to the principal paper consuming markets of the country. Rapid growth and easy logging conditions put production on a favorable basis. The South is also well situated with respect to supplies of sulphur, clay and limestone, and many developed and potential power sources are at hand. Significant progress has also been made toward the successful bleaching of southern kraft pulp, thus placing it on the threshold of an all-purpose product in the paper industry. Realization of the potentialities of a southern newsprint industry seems to await only on an enterprising pioneer. All in all, paper making south of the Mason-Dixon Line is on the verge of much greater things.

How Soybeans Help Build Fords

By ROBERT L. TAYLOR
Editor, The Michigan Technic,
Ann Arbor, Mich.

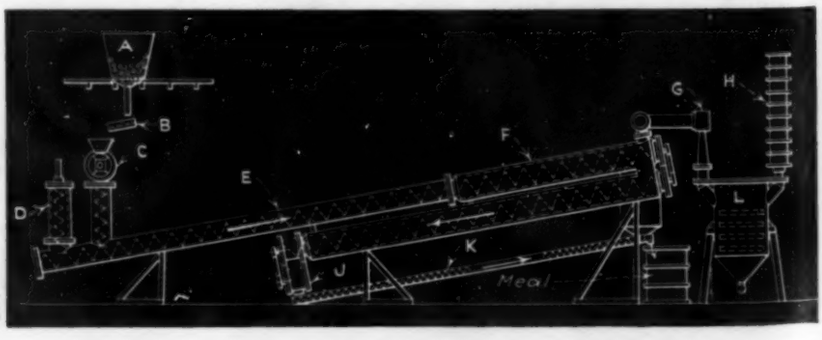
The bean has been grown in Asia for over 5,000 years but strangely enough it has been almost a curiosity in this country until recently. Within a decade it has advanced from a position of minor to one of major importance. And now the Ford Motor Co. adds to the almost legendary list of uses by converting the oil or meal into enamel, gear shift knobs, window frames and many other parts for the automobile.

MANY YEARS AGO it was written by the chemical prophets that some day the lowly soybean would be transformed into an important industrial material to compete with steel and synthetic plastics. There was nothing particularly complicated about that transformation from a chemical engineering viewpoint; but an economic stimulus was lacking. The industry seemed to need an outside impetus if ever the prophecy was to be turned into profits. Henry Ford, who has a reputation for supplying just that sort of impetus to technology in other fields, is today sponsoring a program that promises a tremendous soybean development. Every one of the million or more cars he expects to make in 1936 will require 10 to 15 lb. of soybean plastics for window frames, gear-shift knobs, horn buttons and electrical parts. Even greater utilization of the lowly bean is represented by the 5 lb. of oil consumed in foundry sand-cores and body enamel for every Ford that rolls off the production line this year.

It goes almost without saying that the Ford Motor Co. finds economic justification for this growing use of soybean products. The necessity for lighter automobile parts that are easy to fabricate and require no costly surfacing and finishing is a manufacturing advantage not to be overlooked. But from Mr. Ford's personal point of view, there is also a social justification.

The problem which led to the soybean development at the Ford Motor Co. was first presented by Mr. Ford to a small group of his officials in 1930. The work was to be a forward step in carrying out his program for the decentralization of industry—in the forging of a closer linkage between agriculture and manufacturing. At that time, he was searching for some product of the soil which could be incorporated into the manufacture of automobiles. A year was spent in working with the various farm crops. Of the entire number investigated, the most promising proved to be the soybean, with its casein which could be used in plastics and its 20 per cent of oil which suggested a new source of vehicle for paints and body enamels. Having established the value of the bean, and since the original purpose of the experiment was decentralization, the objective became one of developing a simple oil-extraction process which could be operated in a farm community by the individual farmer or cooperatively by a group.

A simple and rugged unit for solvent extraction resulted from experiments which were carried out at Greenfield Village, Dearborn, Mich. The process developed is one of cold extraction at atmospheric pressure, involving a continuous unit with a capacity of 500 lb. of beans per hour and capable of operation by one man. The entire unit consists of a flaker, continuous extractor,



Oil extractor diagram (A) bean hopper, (B) feeder, (C) flaker, (D) filter, (E) percolator tube, (F) steamer, (G) jet condenser, (H) scrubber, (J) barrel valve, (K) meal conveyor, (L) solvent tank, (M) still

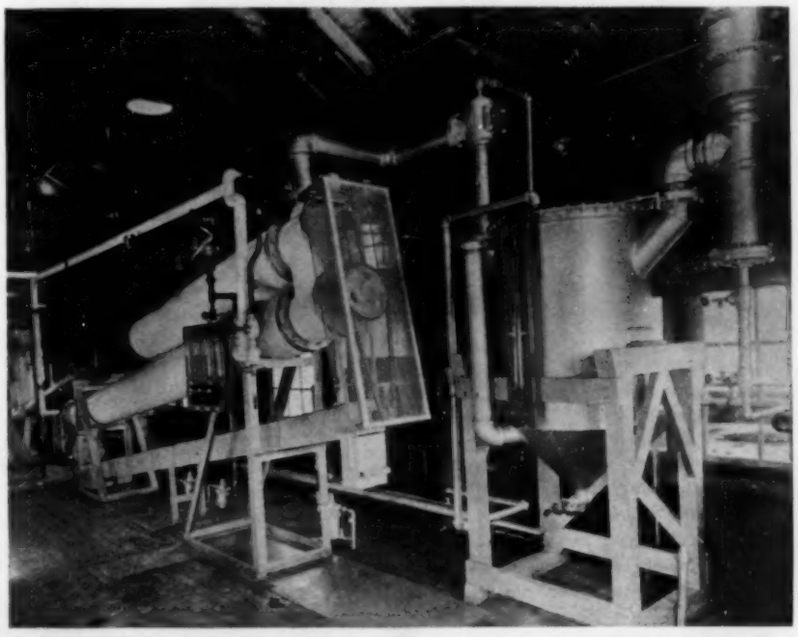
filter, and solvent recovery system such as are shown.

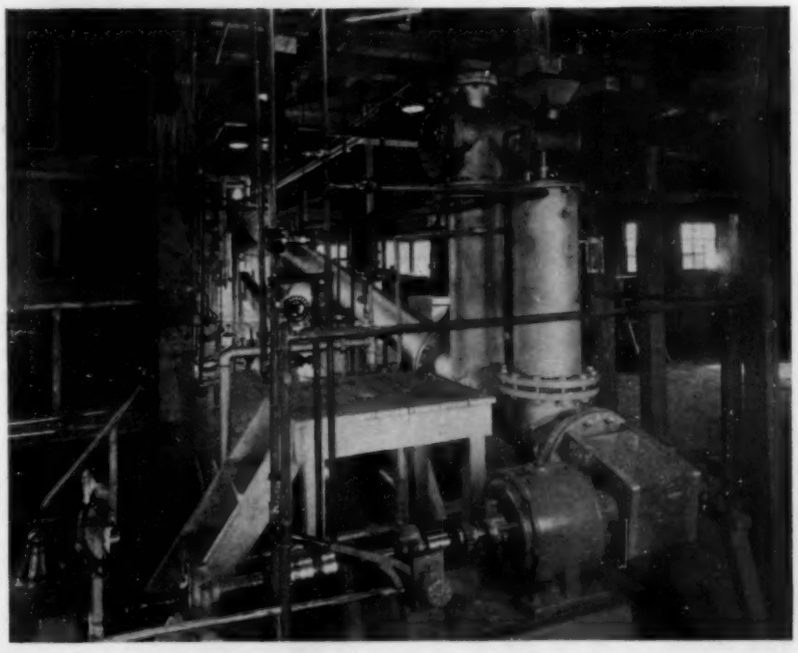
The small Greenfield Village plant obtains its soybeans from a rural mill where they are cleaned and weighed, having been received originally from the farmers' silos. Since the beans can be stored indefinitely as long as the moisture content is kept below 12 per cent, it is not difficult to maintain a constant supply throughout the year.

In the extraction building, the beans enter a hopper on the second floor from which they are fed through a vertical wooden chute to the flaker. The fact that this piece of equipment is an integral part of the extractor permits the process to be fully enclosed from the time the whole beans enter the flaker until the withdrawal of the meal through a barrel valve at the end of the extraction process. The flaker itself operates on the principle of a meat grinder, the body being a section of 12-in. pipe containing a revolving steel core on which is a half-inch raised spiral. The beans are forced out through an adjustable slit at one end. It is by varying the thickness of the flakes that the residual oil content of the meal is controlled within a range of from 0.5 to 6.0 per cent.

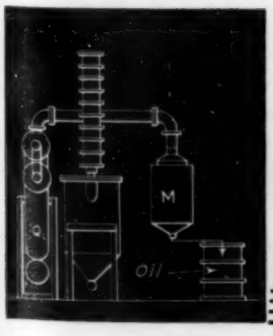
The flaked beans, along with a very small amount of oil that has been pressed out, are carried down from the flaker about 3 ft. in a closed vertical screw conveyor to the extractor proper. This is simply a piece of 12-in. standard steel pipe, 30 ft. in overall length, and set at an angle of 10 deg. with the horizontal. Operation is countercurrent, the bean flakes being carried upward by a screw conveyor and the solvent running down the inclined pipe, or "percolator" as the tube is called. Introduction of the solvent at a point about half way down the tube allows the upper portion to be used as a steamer. There, by the use of a steam jacket and live steam, the last traces of solvent are vaporized from the meal. The steam and solvent vapors pass out of the upper end of the steamer to the solvent recovery system, while the wet, solvent-free meal is dropped to another steam-jacketed, inclined pipe which acts as a dryer. Carried down the dryer tube by means of a screw conveyor, the meal emerges through a barrel valve to an open conveyor, which takes it with a final moisture content of about 8 per cent, to steel drum containers.

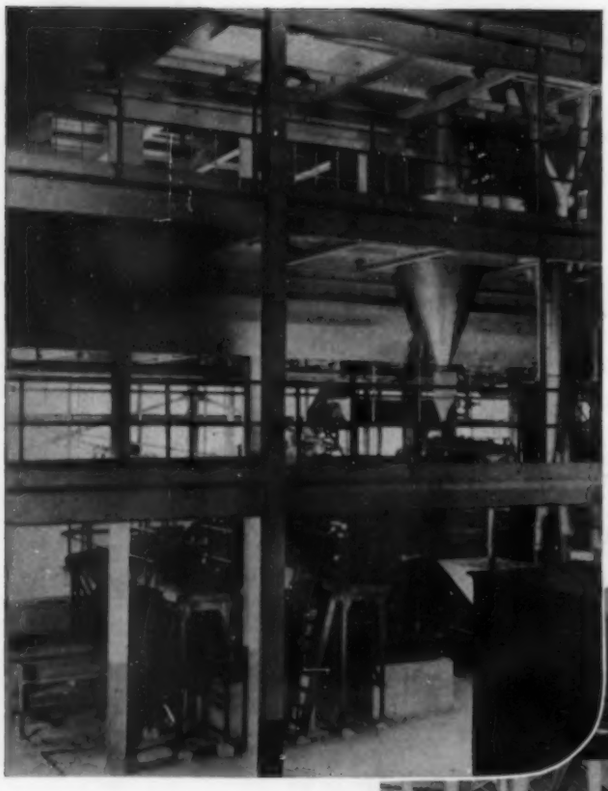
To the lower end of the extractor tube there is welded vertically another short section of 12-in. pipe in which is set a continuous filter for the spent solvent and oil mixture. This consists of an inner perforated cylinder lined with heavy filter cloth. The solvent and oil rise in the cylinder and continuously filter through the cloth to

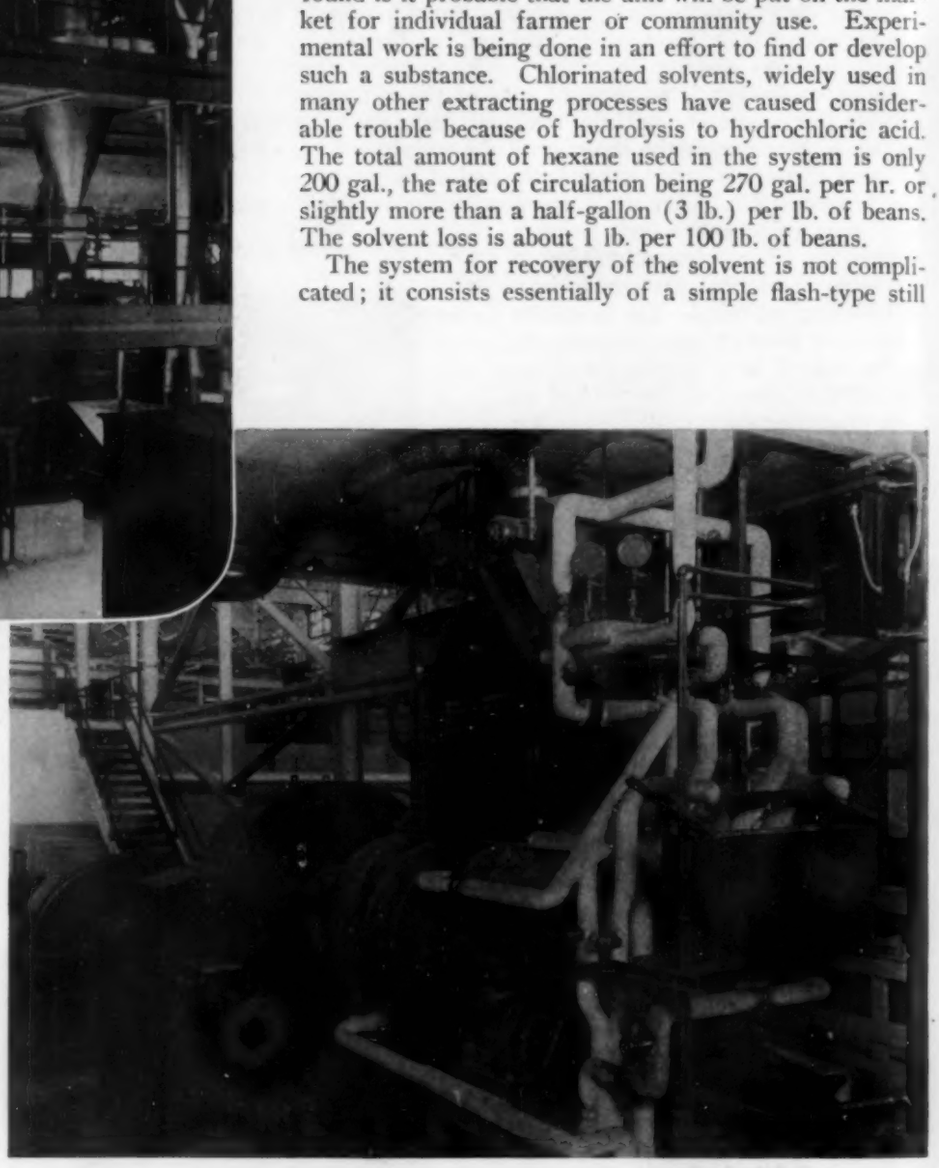




The oil extractor is simply a piece of 12-in. steel pipe, 30 ft. in length, and set at an angle of 10 deg. Operation is countercurrent, the bean flakes being carried upward by a screw conveyor and the solvent running down the inclined pipe. Introduction of solvent at a point about half way down the tube allows the upper portion to be used as a steamer







Whereas during the mixing process the molding material lumps and becomes tough the final contents of the mixer must be put through a Banbury which gives uniform density to the mass by its intense masticating action. Next it goes to a Raymond kiln mill, the hot air and gases carrying the ground material up through a vertical pipe to a cyclone operator. The powder goes to a tumbler and from there it is fed to the molding machines

be carried down and piped to the solvent recovery still. This type of filter eliminates much of the troublesome work of stripping the cloth. Inside the inner cylinder is a hand operated spiral scraper which is turned occasionally to remove the cake when it builds up and to cause it to drop to the bottom of the cylinder. It is then carried away by the screw conveyor in the extraction tube.

At the present time, the solvent used is hexane. Explosion and fire hazards have been reduced by open construction of the extraction building and complete enclosure of the solvent cycle, with the solvent at all times either in a cold and liquid condition or as vapor mixed with steam. The danger of a dust explosion also is lessened by the closed system. Dust has not proved a serious menace, however, since laboratory tests indicate that soybean flour mixtures are much less explosive than ordinary wheat flour. The solvent-extraction process has proved to be fairly safe when in experienced hands, but not until a suitable non-flammable solvent can be found is it probable that the unit will be put on the market for individual farmer or community use. Experimental work is being done in an effort to find or develop such a substance. Chlorinated solvents, widely used in many other extracting processes have caused considerable trouble because of hydrolysis to hydrochloric acid. The total amount of hexane used in the system is only 200 gal., the rate of circulation being 270 gal. per hr. or slightly more than a half-gallon (3 lb.) per lb. of beans. The solvent loss is about 1 lb. per 100 lb. of beans.

The system for recovery of the solvent is not complicated; it consists essentially of a simple flash-type still and a solvent condenser and cooling tank. The still is heated by a steam jacket. The solvent and oil mixture from the filter enters the bottom of the jacket in a closed coil which carries it up through the steam space and then opens into the still body from the top. By the time the mixture leaves the coil at the top it has been preheated to such a temperature that the solvent vaporizes completely. The oil runs down over baffles to the cone bottom where a small amount of live steam is injected to remove the last of the solvent. The solvent-free oil then goes to drum containers. The solvent vapors pass from the top of the still to a cold solvent jet condenser which empties into the solvent cooling tank. In this tank, four automobile radiators supply a total cooling surface of

240 sq.ft. It is claimed that such a cooler takes up only about one-half the space volume of a standard surface cooler of equivalent area. The non-condensable gases escape through a scrubber vent at the top of the cooling tank, a small amount of soybean oil being used as the scrubbing agent.

The cost of the entire extraction unit, including the solvent recovery system, is estimated at a figure low enough to put it well within the reach of rural cooperative organizations. This means that with the already receptive attitude of the farmer toward the soybean idea, the discovery of a safe solvent is the one remaining obstacle in the path leading to the completion of this important step in the Ford decentralization program.

Both soybean oil and the meal are finding a wide variety of uses in Ford automobile manufacture. The extraction unit, only one of which is being operated by the company at the present time, supplies but a small fraction of the total oil and meal consumed. A large additional quantity of oil is being purchased and used, chiefly in body enamels. For this purpose, part of it is mixed with a small amount of tung oil and used as the enamel vehicle, and part is used in the manufacture of a glyptal resin which serves as the base of the Ford body enamels. This resin is being supplied partly by production at the Ford plant and partly by other companies according to Ford specifications. The general process followed in the production of the resin consists of, first, hydrolysis of the oil with Twitchell's reagent to yield glycerine and fatty acids, second, addition of more glycerine and then, finaliy, treatment of the mixture with phthalic anhydride.

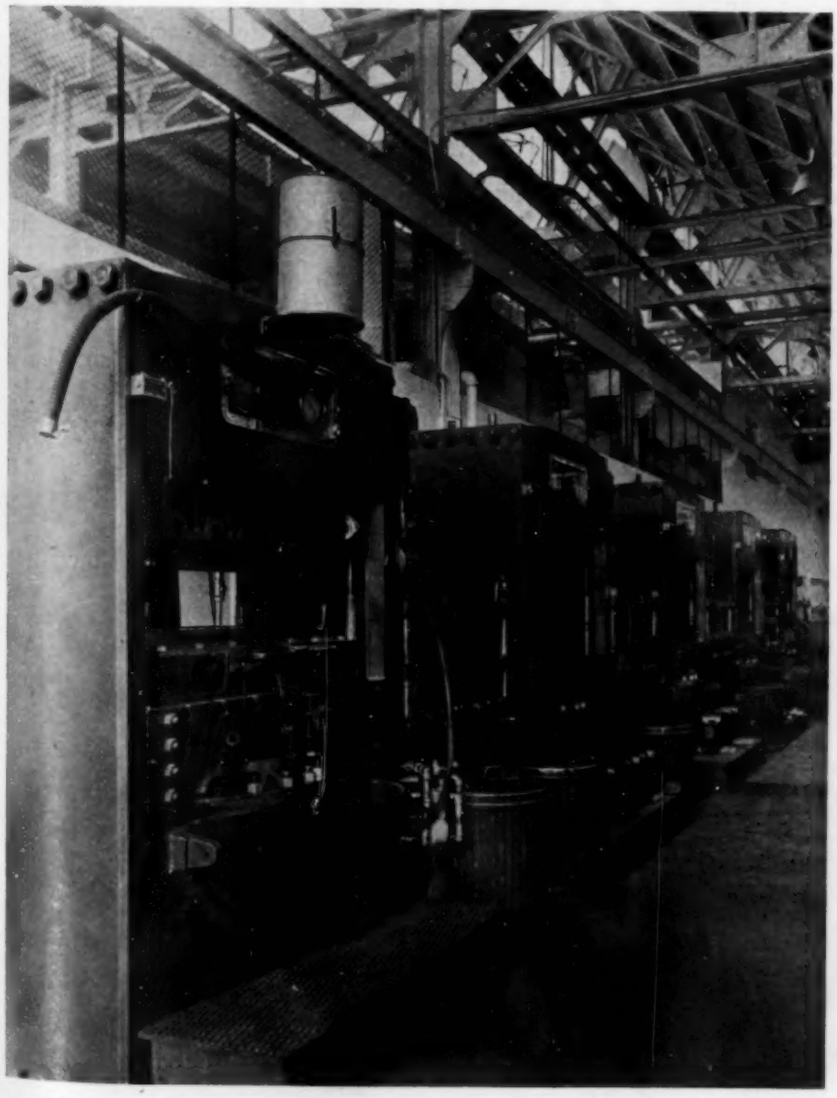
Some of the oil is being used in the foundry as a sand-core binder. For this use, one part of the fresh oil is mixed with one part of an oil which has been heated with a natural resin. Experimentation has shown that blown soybean oil may be used in the production of artificial leather.

Lecithin, a phosphorous-containing glycerol ester or phosphatide having valuable emulsifying and anti-oxidant properties, is found in the bean to the extent of about 2 per cent, and comes out with the oil in the extraction process. The substance is not being isolated at the present time, although its use as an anti-oxidant in rubber is being investigated experimentally. It is claimed that bean oil from which the lecithin has been removed is inferior for lubrication purposes, but its properties affecting other uses remain unchanged.

The extraction process leaves a residual meal containing, on a dry basis approximately 48 per cent protein, the major portion of which is casein, 38 per cent carbohydrates, 7 per cent cellulose, and 7 per cent ash. Making use of this high casein content, the production of molding plastics consumes the greater part of the meal, requiring over 4,000,000 lb. per million cars.

Early work in soybean plastics indicated that the pure casein-formaldehyde product displayed a decided tendency to absorb moisture over a period of time, often to the extent of 20 per cent, with a final result of serious warping and cracking. For that reason, present practice calls for the addition of a certain amount of phenol, giving a composition of phenolic and casein-formaldehyde product which is both waterproof and durable. Although isolation and purification of the casein gives a higher grade plastic, the added expense has not been justified in view of the present satisfactory results obtained by using the whole meal. Since phenol is a good solvent for soybean meal, this method makes available both the casein for the formaldehyde reaction and the carbohydrates for filler, thus cutting the cost to a figure considerably lower than that of a straight phenolic plastic. Wood flour is used as additional filler.

Ford's welding is being done in a



Battery of hydraulic presses which form plastic window moldings for Ford V-8 cars at the Rouge plant of Ford Motor Co.

part of the huge glass works at his River Rouge plant. In the main building will be housed the mixing equipment and molding machines capable of turning out 100 tons of plastic per day in the form of distributor parts, gear shift lever knobs, light switches, horn buttons, coil parts and window frames. The total outlay will represent a construction and equipment cost of approximately $4,000,000. To date, the program is only partially completed, present capacity being about 6 tons of plastic per day.

Soybeans Used in the Manufacture of the Ford Car

(a) Soybean Oil-Free Meal

Car Part	Number of Cars	Oil-Free Meal Pounds	Soybeans Bushels	Soybeans Acres
Gear shift knob	1,000,000	66,666	1,460	91
Horn button (large)	1,000,000	22,200	487	30
Light switch	1,000,000	80,000	1,800	113
Distributor caps	1,000,000	320,000	7,200	452
Distributor bars	1,000,000	300,000	7,000	440
Coil cap	1,000,000	100,000	2,333	220
Coil plate	1,000,000	140,000	3,100	195
Window frames	1,000,000	3,333,333	74,074	4,560

(b) Soybean Oil

		Gallons		
Foundry sand cores	1,000,000	288,600	193,920	12,120
Enamel	1,000,000	360,000	270,000	16,875

The meal which comes into the plant is carried in a closed Redler conveyor from the storage room to an ordinary attrition mill where it is ground to a fine flour. Then the plastic batch is weighed into a jacketed Baker-Perkins mixer where it is worked for two hours at 200 deg. F. and from two to three hours at a lower temperature. The weighing devices for the phenol, formaldehyde, and ammonia are each controlled automatically by a photo-electric cell arrangement capable of adjustment for any desired weight. The individual batches are varied from time to time to meet the different physical properties required in the various finished parts. A representative mixer batch consists of 330 lb. soybean meal, 250 lb. phenol, 250 lb. formaldehyde, 300 lb. wood flour, 30 lb. ammonia, and 25 lb. lime. The ammonia and lime serve as catalysts for the formaldehyde reaction.

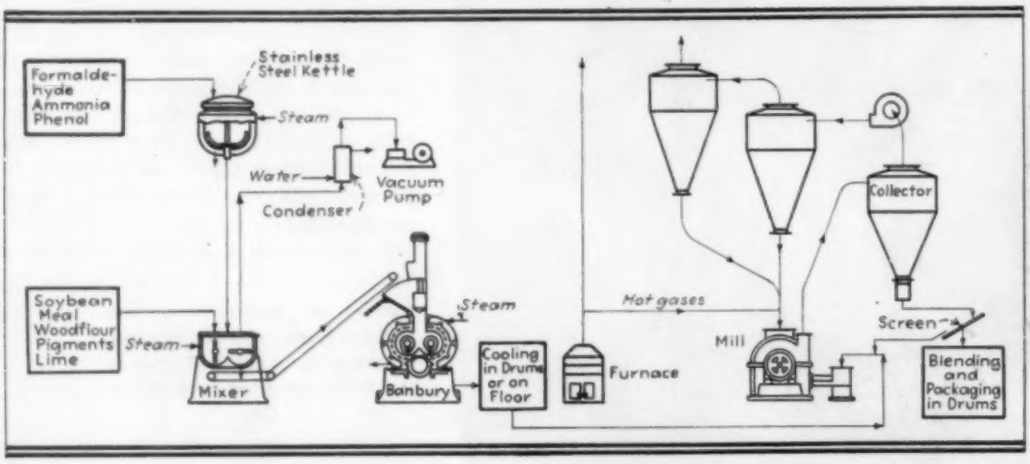
Coloring pigment is added near the end of the mix, as is also a small amount of zinc stearate and stearic acid which serve as mold lubricants. Whereas during the mixing process the material lumps and becomes tough, the final contents of the mixer must be put through a Banbury internal mixing machine, such as is used in rubber compounding. This large machine, which is driven by a 200 hp. electric motor, gives uniform density to the mass by its intense masticating action. From the Banbury the material goes to a Raymond kiln mill where the temperature is kept below 150 deg. F. in order to avoid premature curing. This mill is of the hammer type and is gas-fired, the hot air and gases carrying the ground material up through a vertical 12-in. sheet-metal pipe to a cyclone separator. There, after separation from the air stream, the dry material falls to a screen from which the oversize drops back to the grinder. The powder goes to a tumbler to obtain a uniform blend, and from there it is fed to the molding machines. These are hydraulic presses which exert a force of 2,000 lb. per sq.in. and operate at a mold temperature of 360 deg. F. The treatment of the material in that part of the processing between the mixing and blending is extremely important, every operation being closely timed so that the last stage of curing, which requires about three minutes, takes place in the presses. Premature curing would mean an unmoldable plastic.

The cost of soybean plastics is greater than steel per pound, but the finishing of steel brings the final cost of many steel parts in excess of that for the finished product fabricated from the soybean material.

The meal finds lesser uses as a core bond in the foundry and as a binder in forming charcoal briquettes. At the Ford paper mill, experimental work is in progress on the extraction of casein from the meal for use as paper sizing.

With a production of one million automobiles annually, the Ford company will require for all purposes more than 450,000 bushels or 28,000 acres of soybeans each year. At the present time, the company owns only 12,000 acres planted in beans, which is more than enough to take care of its meal demand. In the future, Mr. Ford hopes and expects to depend on independent farmers or the cooperative, community extraction units for the bulk of the supply, buying only the oil and leaving the meal to be used as stock feed. He would thus encourage decentralization of industry and strengthen mutual relations between agriculture and industry.

Flow sheet for soybean molding compound production at Ford's River Rouge plant



Soybean meal (extracted)	330	lb.
Wood flour	396.6	lb.
Lime	26.3	lb.
Formaldehyde	250	lb.
Ammonia	26.3	lb.
Phenol	250	lb.
Alcohol	33	lb.
Pigments	75	lb.
Hexamethylene tetramine	26.3	lb.
Water	12.4	lb.
Stearic Acid	4.1	lb.
Zinc stearate	4.1	lb.

A New Safety Glass

By J. H. SHERTS and E. L. FIX

Duplate Factory
Pittsburgh Plate Glass Co.
Creighton, Pa.

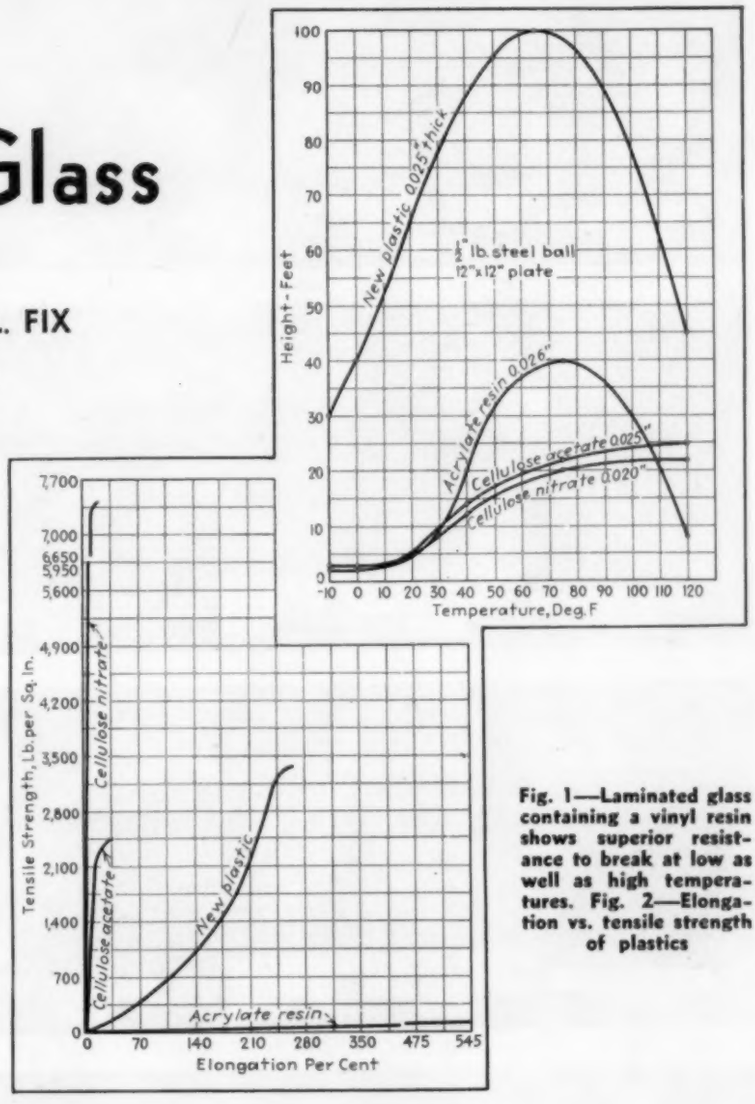


Fig. 1—Laminated glass containing a vinyl resin shows superior resistance to break at low as well as high temperatures. Fig. 2—Elongation vs. tensile strength of plastics

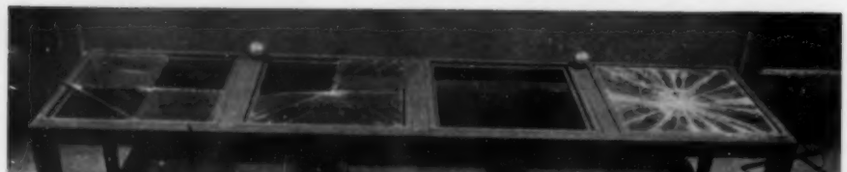
A NEW TYPE of safety glass has been developed and is being manufactured on a commercial scale. The new sandwich plastic material is a variation of Vinylite, known as Vinylite X, to which has been added a new plasticizer. The sheets of plastic material, produced by any of the standard methods, are placed between the two plates of glass, and the whole is subjected to heat and pressure to secure adhesion of the plastic and glass. The result is a safety glass that is superior to the standard products now available. It has much greater resistance to break at low temperatures than other varieties of glass. This new product is a joint development of the chemists of the Duplate research laboratory and of the Carbide and Carbon Chemicals Corp. fellowship at Mellon Institute.

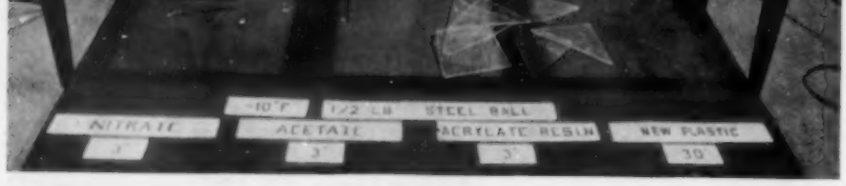
John Crewe Woods invented safety glass in 1905. And while many improvements have been made in laminated glass since his invention it is interesting to note that cellulose nitrate is still used in appreciable quantities as the interlayer. Of all the materials that have been proposed as substitutes for the nitrate plastic, only two have reached commercial proportions, namely, cellulose acetate and acrylate resin.

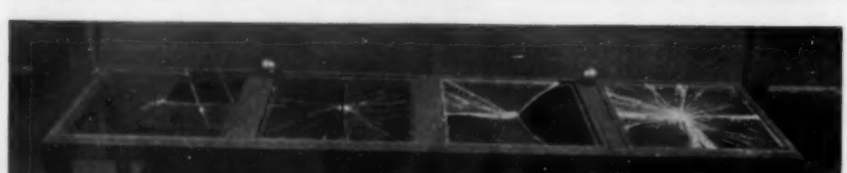
The use of large quantities of cellulose acetate as a plastic sheet is mainly due to the fact that it is not discolored and decomposed to the same degree as the nitrate by sunlight. We are all familiar with the brown discoloration of the early safety glass windshields after they had been in service for a year or two. This discoloration was due to actinic rays from the sun. Safety glass made since 1930 does not develop this defect for one of two reasons —either cellulose acetate plastic is used instead of cellulose nitrate, or a special actinic ray filtering glass is used. This special glass prevents the harmful actinic rays of the sun from reaching the plastic sheet and therefore prevents their harmful effect. The composition of the special glass is generally the same as ordinary glass except that it has a higher iron content. Increasing the iron content also imparts a cast to the glass which serves as an additional advantage of reducing road and general reflection glare thereby reducing eye fatigue, headache, and other ills.

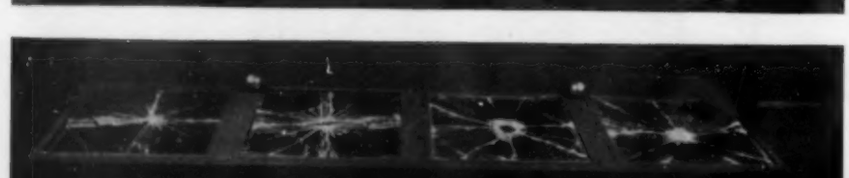
Although present plastics have been fairly satisfactory from the standpoint of the safety glass industry, and have saved humanity countless injuries from flying glass and missiles, it has long been recognized that none of them was all that could be desired. Each has its good points as well as certain deficiencies. The most important of these are as follows: Tendency to lose toughness and strength at low temperatures; tendency to absorb moisture and separate around the edge; tendency to lose plasticizer and shrink, resulting in cracks at the edge; lack of elasticity when struck or cracked, thereby creating more shock than is desirable in absorbing a blow; high temperatures are required for cutting; edge grooving and sealing is required, thereby necessitating delay and damage in making replacements.

It is reasonable from these remarks that the problem of developing a completely satisfactory plastic was not a simple one. We were fortunate, however, in having a









Safety glass containing Vinylite X and a suitable plasticizer has a higher resistance to the fall of a one-half pound steel ball or an eleven pound shot bag than glass made with cellulose nitrate, cellulose acetate or acrylate resin as the sandwich material. This new laminated glass is a joint development of the Duplate laboratory of the Pittsburgh Plate Glass Co. and the staff of the Carbide & Carbon Chemicals Corp.

large, well established market, calling for approximately 10,000,000 lb. of plastic per year, as an incentive for developing interest and inspiring cooperation of all producers of resins and large research departments working in the field of resins.

Naturally, under these conditions a great number of materials and modifications of them were suggested and tried out. Most of them were found to be wanting on so many counts that they were discarded at once. The most promising were various esters and ethers of cellulose, such as cellulose propionate, ethyl cellulose, benzyl cellulose, etc.; resins such as vinyl acetate, chlor acetate, methyl acrylate, urea formaldehyde, and mixtures of cellulose derivatives and resins.

In following up and testing these many materials the Duplate organization established a cooperative arrangement with the Carbide and Carbon Chemicals Corp. Through this work encouraging results with a newly developed resin were soon obtained. From this point on progress was rapid, but not without discouraging setbacks.

The new resin was called Vinylite X. It was crude at first to be sure, but when properly plasticized and converted into sheets it had at least that one most desirable property of largely overcoming brittleness at temperatures in the neighborhood of 0 deg. F.

Refinements of other essential characteristics resulted from the combined efforts of the two laboratories. Finally, after two years were consumed in modifying the plastic, testing, and following leads, a satisfactory plastic sheet was produced. This plastic conformed to the specification originally outlined by us for an ideal laminated glass.

The plastic is produced by com-

pounding Vinylite X and a plasticizer. This vinyl resin is an amorphous, white powder, and the plasticizer should be a very high boiling, very stable, water-white liquid. After the two ingredients are mixed the compound is converted into sheets approximately 0.025 in. thick. This is done either by the standard method of calendering, pressing into blocks and finally slicing off sheets of desired thickness by means of a planer; or by the extrusion process, in which the compound is reduced to a lacquer-like mixture by volatile solvents and then extruding through an orifice in the form of a sheet. The sheets are next dried or seasoned to eliminate the solvents.

Sheets thus produced are placed between previously cleaned plates of glass, and the resulting sandwich subjected to heat and pressure which removes the air from between the laminations and causes the plastic to adhere to the glass.

Laminated safety glass in which this plastic is used has not only the good properties of safety glass in which cellulose acetate, nitrate, or acrylate plastic is used, but in addition certain other desirable properties. In Fig. 1 it is shown that the new safety glass known as Hi-Test Duplate, at 0 deg. C. is approximately 10 times as resistant to the drop of a ½ lb. steel ball as the other types of safety glass; about 4 times as good at 70 deg. F.; and approximately 3 times as good at 110 deg. F.

Differences in characteristics among the several types of plastics are shown in Fig. 2. High elasticity is a desirable property in a plastic material to be used in safety glass. A blow from a man's head or shoulders will be absorbed gradually if the glass is elastic. The blow given the less elastic safety glass made with cellulose acetate or nitrate is absorbed more abruptly.

Because of the high moisture resistance of the new plastic it is not necessary to groove and seal the edges for the purpose of preventing separation of plastic and glass. Moisture is only absorbed after long and continuous exposure, and in such cases the moisture merely whitens the edges slightly. On returning to a dry atmosphere the moisture and cloudiness quickly disappear with no detrimental effect whatever to the plastic. For this reason, therefore, it is unnecessary to seal the edges to prevent entrance of moisture.

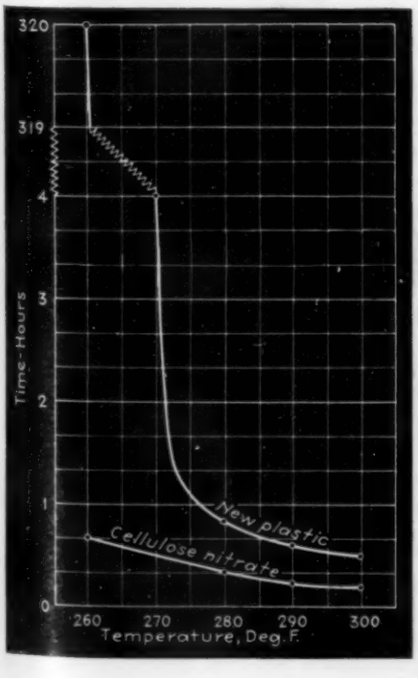
From the viewpoint of small jobbers and replacement shops, it is interesting that the new type of glass does not require edge sealing. To seal an edge it is necessary to groove or remove the plastic from between the plates to a depth of ⅛ in., and then fill this groove with a pitch-like material, all of which requires a great deal of skill, delay, and loss due to damage and breakage.

Due to the high elasticity of this plastic, safety glass in which it is used may be cut by: first, scoring and cracking the glass on both sides, and then pulling the cracks apart; second, stretching the plastic at ordinary room temperature sufficiently to permit inserting a razor blade and cutting the plastic. This greatly simplified operation is also of importance to the replacement shop, as it eliminates delay and breakage occasioned by the present method of cutting safety glass which requires that each cut be preheated for several minutes before the razor blade can be inserted.

This plastic laminated between plate glass shows practically no discoloration after 1,000 hours exposure to the Uviarc test in the laboratory. Two years of flat exposure to the sun in Florida also causes no change in color. It, therefore, requires no protection of a special composition glass as does the nitrate plastic. It is estimated that 200 hours exposure to the Uviarc is equivalent to 4 years of automobile windshield exposure in the temperate zone and 2 years in the tropics.

The new material requires no adhesives for cementing it to the glass. This property reduces the complications and losses arising from adhesives and their application.

This plastic at temperatures of approximately 250 deg. F., which is required for baking enamels at the present time, does not decompose or develop any other defects such as are common with certain other types of laminated glass. Fig. 4 shows that the plastic did not decompose in 320 hours at 260 deg. F., whereas under similar conditions nitrate plastic decomposed in 40 minutes. It should, therefore, be practical to pass glazed automobiles through enamel baking ovens without damaging the new safety glass.



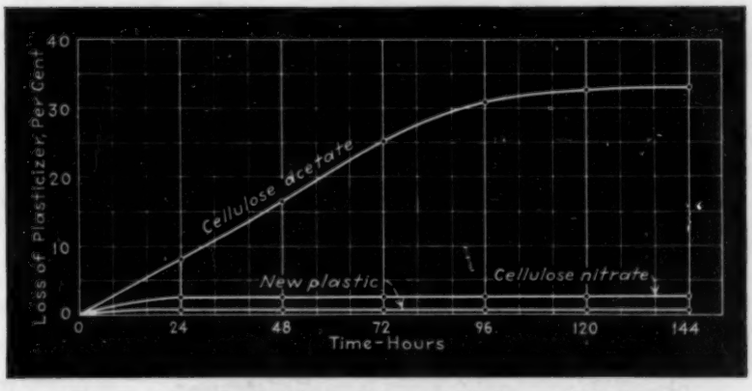


Fig. 3—Loss of plasticizer of several plastics at 120 deg. F.
Fig. 4—Comparison of stability of laminated glass made with cellulose nitrate and with new plastic

By SHEPPARD T. POWELL
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and
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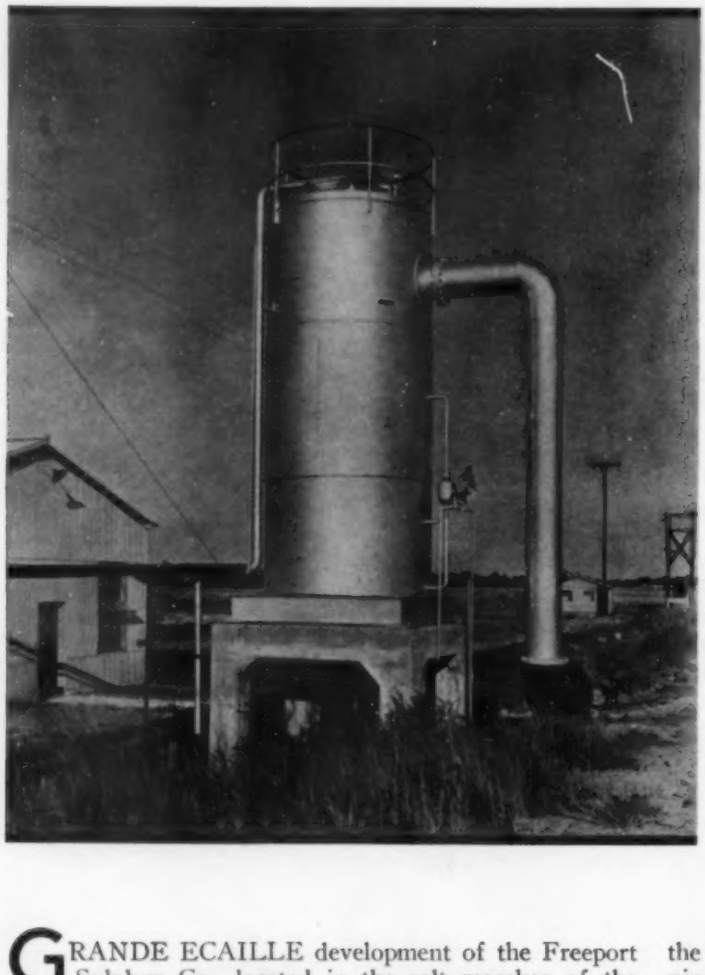
Vacuum Deaeration



Vacuum deaerator for removal of dissolved oxygen from raw Mississippi River water at the Port Sulphur pumping station of the Freeport Sulphur Co.

GRANDE ECAILLE development of the Freeport Sulphur Co., located in the salt marshes of the Mississippi delta, approximately fifty miles below New Orleans and within four miles of the Gulf of Mexico, has attracted considerable interest because of the engineering problems encountered. The terrain consists of lakes and bayous surrounded by low marshes, supporting no vegetation other than grasses. The exploitation of the Grande Ecaille salt dome has required construction supported entirely on piles, and complete provision of the many essentials to the operation of the development.

Sulphur mining in the Gulf Coast region of the United States is carried out by the well-known Frasch[1] process. Briefly, this involves melting the sulphur by pumping hot water into the rock formation, and forcing the molten material to the top of concentric well-casings by means of compressed air. The operation of the process at the properties of the Freeport Sulphur Co. has been previously described.[2,3]. A considerable amount of "mine water" is required, as well as boiler feedwater for generating the steam which is used to heat the mine water, operate the pumps, and generate power. It will be obvious that a source of water capable of supplying large volumes is one of the most important requirements of the industry. The water from the bayous of the Grande Ecaille area is not satisfactory because of its high salt content. It therefore was found necessary to pump water from the Mississippi River, which is nine miles northeast of the plant.

A seventy million gallon earthen reservoir and a pumping station were constructed at the right descending bank of the river, and the water is pumped from this point to Grande Ecaille through a welded steel pipe line. Local conditions required the use of a welded steel pipe in preference to cast iron or other materials, and the welded construction prohibited the use of protective coatings on the inside of the line. The pipe line is approximately nine miles long. The first 1.9 miles consist of two 12-in. mains, and the major section of 6.6 miles which follows is a single 14-in. pipe. This terminates in two 12-in. lines which make up the final half mile. The main reservoir pumps are electrically driven, the current being supplied from the generating station at Grande Ecaille.

In April, 1934, it was found that the carrying capacity of the line had dropped from its original volume of 4,090,000 gal. per day to 3,170,000 gal. per day, a reduction of 22 per cent in 129 days. Inspection of the pipe showed extensive tuberculation resulting from active corrosion. This condition increased the friction loss in the line, and accounted for the decrease in carrying capacity.

The problem was serious not only because it limited the operations of the plant by reducing the available water supply, but also because of the rapid deterioration and

Combats Cold-Water Corrosion

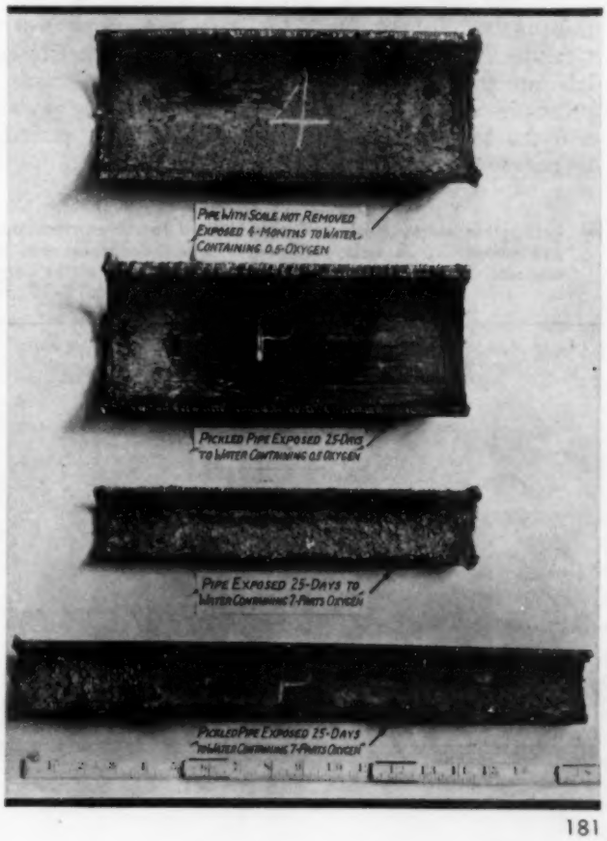
possible premature loss of the pipe line. In some sections of the line, pitting had penetrated to the extent of more than 8 per cent of the thickness of the pipe wall. The rapid rate of corrosion was indicated by the reduction in the dissolved oxygen content of the water in its passage through the line, as measured by analyses of samples taken at the reservoir and at Grande Ecaille. The consumption of dissolved oxygen by corrosion of the pipe between the reservoir and Grande Ecaille was 5.6 parts per million. No increase in iron content of water was observable and all evidence indicated that loss of capacity was due to increasing deposit of corrosion and bacterial products in the pipe.

Because of the seriousness of the situation, it was necessary to undertake corrective measures to restore the carrying capacity of the line and to reduce further corrosion as much as possible. An effort was made to restore the deposits by pumping an inhibited 0.5 per cent hydrochloric-acid solution through the mains. This restored nearly four per cent of the original carrying capacity, but inspection revealed that it had failed to remove rust tubercles to an appreciable extent. Further, the rate of corrosion was materially accelerated following acid treatment because of the exposure of fresh metal surfaces. An effort was then made by the management to lay down a protective silicate scale by treating the water with sodium silicate. On examination of the pipe line after this treatment, there was little indication that a silicate film had developed, and practically no inhibition of corrosion was observed. The treatment was abandoned because of the definite appearance of silicate scale in the boilers for which this supply is also used as feedwater. The absorption of oxygen by the pipe line did not decrease during the application of silicate, indicating that the silicate was not protecting the line. After the silicate and acid treatment had failed, chlorine was used and later sodium sulphite treatment was started.

Consideration was given to laying down a calcium carbonate scale on the inside of the line by the addition of lime to the water at the inlet end of the pipe. This latter treatment was found to be impracticable due to the chemical characteristics of the water. With a pH already around 8.0, and a complete absence of bicarbonates, lime application would have resulted in a deposition of such quantities of lime sludge as further to reduce the carrying capacity of the line and there was no assurance that corrosion of the pipe would be lessened. Experiments demonstrated that properly regulated sodium sulphite treatment might have been satisfactory with respect to dissolved oxygen removal, and the consequent prevention of corrosion, but its cost was so high as to render such a method infeasible for long periods of time.

During the period of experimentation, sections of the pipe line were cleaned mechanically on several occasions. This expedient markedly increased the carrying capacity of the line, but did not alleviate the progressive destruction of the pipe by corrosion. The effect of the various

Steel pipe with and without mill scale, showing relative corrosion resultjng from use of raw Mississippi River water and the same water after deaeration in a vacuum deaerator


Pipe With Scale Not Removed Exposed 4-Months to Water Containing 0.5-Oxygen
Pickled Pipe Exposed 25-Days to Water Containing 0.5 Oxygen
Pipe Exposed 25-Days to Water Containing 7-Parts Oxygen
Pickled Pipe Exposed 25-Days to Water Containing 7-Parts Oxygen

corrective measures which were employed has been plotted graphically and is shown on page 183.

Following the experience described above, one of the authors[4] became associated with the study of the problem. It was obvious that the most effective remedy would be to deaerate the water, which would definitely limit its corrosive properties. Consideration was given to removing the dissolved oxygen by (a) mechanical processes, (b) chemicals, or (c) a combination of these methods. Chemical deaeration had proved relatively effective but was too costly. The mechanical removal of dissolved oxygen seemed to present an insurmountable obstacle because of the large volumes of water handled. Although deaeration of cold water under vacuum had been carried out on a small scale, no plant of this type and of capacity approaching the requirements in this case, had to the knowledge of the authors ever been constructed in this country although this process had been employed successfully at Coolgardie, Australia. It seemed possible that advantage might be taken of studies made at that time.[5] These were carried on over a period of years by a board which had been commissioned by the Western Australian government to solve the problem of corrosion on a 350-mile length of 30-in. steel pipe. These studies proved that corrosion in this line could be completely inhibited by removal of the dissolved oxygen in the water. A novel step was taken with the construction, in 1917, of a mechanical deaerator for treating large volumes of cold water. It consisted of two towers, each with vacuum lines at their tops and capacities of 3,000,000 gal. per day. Cold water was delivered into the upper compartment of each, and permitted to fall through the tanks in rain fashion. The deaerated water then gravitated to a standpipe at the pumping station. Questionnaires sent to Australian officials confirmed previous reports that complete satisfaction had been given by this 6,000,000 gal. per day installation.

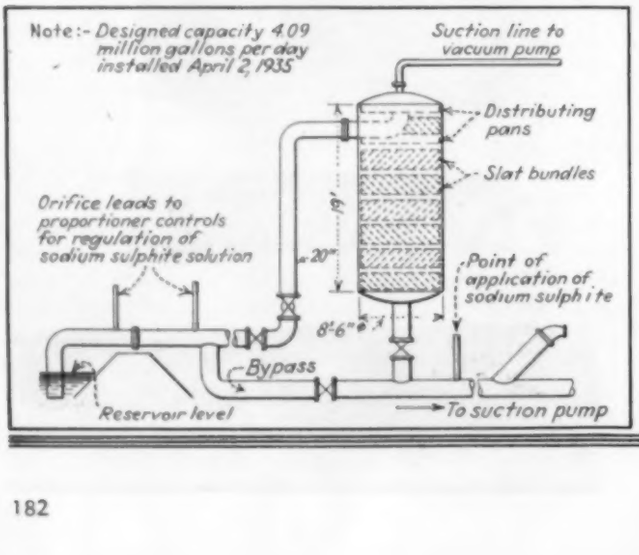
Further confirmation of the practicability of applying this method of treatment to the water supply for the Grande Ecaille mine was obtained through preliminary laboratory experiments. A pilot plant incorporating the principles of the Coolgardie apparatus was then installed, and the tests which were conducted over a period of three months not only proved the feasibility of the method but yielded much in the way of operating characteristics which could be used in the design of a large installation.

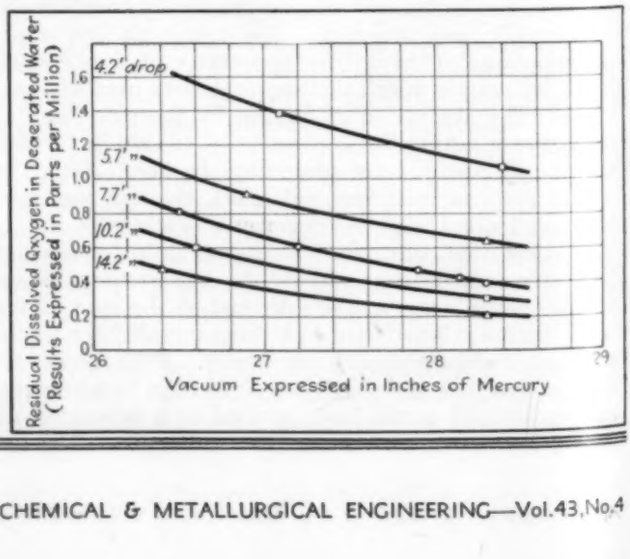
Due in part to the presence of micro-organisms capable of consuming carbon dioxide and giving off oxygen, the dissolved oxygen in the water at times reached 123 per cent saturation, varying from 6 to 10 parts per million depending on temperature and light conditions. These aquatic growths were also responsible for the removing of free carbon dioxide and the conversion of bicarbonates to normal carbonates. It was demonstrated that the growth of micro-organisms could be controlled by systematic routine analyses of the water to detect the species present, and periodic treatment of the reservoir water with copper sulphate. This prevented the dissolved oxygen from exceeding its saturation value, but it was nevertheless apparent that a deaerating plant would be required to handle considerable volumes of gas.

The capacity of the pilot plant used for experimental purposes was 100 gal. per minute. With this unit, operation of the vacuum pumps to maintain a vacuum equivalent to 28.5 in. of mercury resulted in a reduction of the dissolved oxygen content to 0.33 part per million, which was approximately 95 per cent removal. The water thus treated was passed through a 4-in. discharge line, and inspection of this pipe after three months showed that no tubercles had developed. It was believed that mill scale had been an accelerating factor in the corrosion of the pipe line, but the extent to which mill scale would promote corrosion by deaerated water was not known. To determine this point definitely, test specimens of pipe were inserted in the discharge line from the deaerator and in a line carrying water with normal oxygen content. Mill scale was removed from some samples, and left undisturbed in others. As illustrated, the deaerated water did not cause serious corrosion even in the presence of mill scale; however, the samples from which mill scale was removed showed less attack in all cases.

It was determined that the final 5 per cent of dissolved oxygen could be removed from the water more economically with sodium sulphite than by mechanical deaeration under a vacuum greater than 28.5 in. Pumping costs to extend the vacuum a fraction of an inch in this range become progressively higher at a rapid rate, while

Left—Deaerating tank and slat-packed tower construction for water supplied to Grande Ecaille mine. Right—Dissolved oxygen remaining in deaerated water when deaerator was operated at various vacuua and with water dropping varying distances in unit. Initial dissolved oxygen content of raw water during tests was 7.9-8.8 p.p.m. Water flow through unit 1800 g.p.m. Temperature 78-79 deg. F. Barometer 30 in. mercury





the remaining 0.33 part per million of dissolved oxygen in the pilot plant effluent could be removed with sodium sulphite at a cost of approximately $1 per million gallons. The operation of the pilot plant demonstrated without question the feasibility of deaerating the entire water supply, depending on the mechanical process for 95 per cent of the oxygen removal and on sodium sulphite for the remainder. It was on this basis that the large scale unit was designed.

The large deaerator is shown in the accompanying photograph and drawing. Water is drawn directly from the reservoir to the deaerator by vacuum. It flows first through two perforated distributing pans, whence it passes over a series of wooden slat bundles placed within the tank, as indicated in the sketch. The deaerated effluent then passes directly into the suction of three 10x8 in. HYC two-stage Allis Chalmers centrifugal pumps. Vacuum is maintained at 28 to 28.5 in. of mercury with an 18x7 in. Worthington dry vacuum pump having an overall efficiency of 39 per cent.

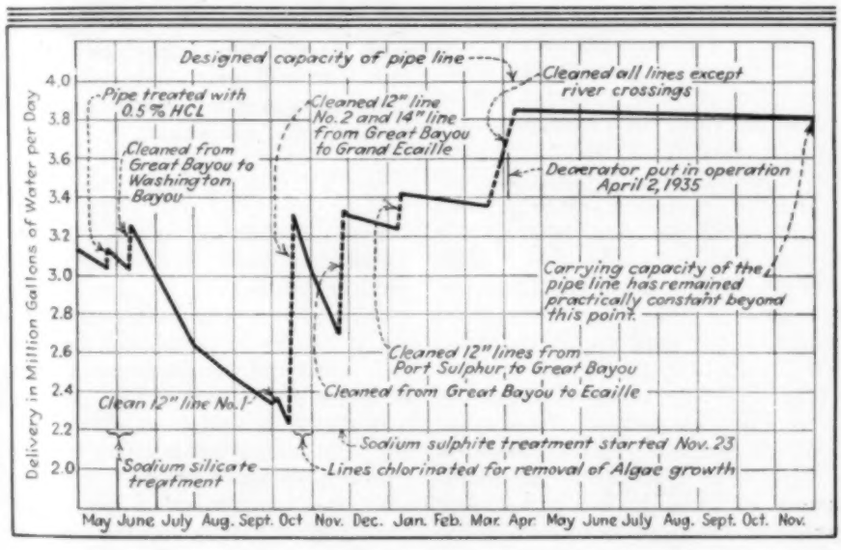
The slat bundles design is quite a deviation from the Coolgardie design, but this was proved both economical and feasible in a second series of preliminary tests which supplemented those previously cited. It was found that deaeration in such a slat-packed unit, when followed by sodium sulphite treatment for removing the remaining traces of dissolved oxygen, could effectively replace the more costly Coolgardie design in which more complete deaeration was accomplished by maintenance of a higher vacuum.

Extensive calculations were made to determine the most efficient arrangement of vacuum pump capacities and other components of the installation. It was found that another scheme more efficient than the original Coolgardie design would have been the utilization of a two-stage deaerator, with a vacuum pump for each stage, in which the first and second stages could be operated under different vacuua. By this means the size of the vacuum pumps could be greatly reduced. Most of the oxygen would be removed under a relatively limited pressure reduction, and only the final traces would be removed under high vacuum. It was decided that this latter design, although more efficient, did not appear to be justified because of the greater cost of installation. Under certain conditions, however, two-stage deaeration may prove of sufficient value to justify the added expense.

To the effluent from the deaerator at the Port Sulphur pumping station, sodium sulphite is added from a Cochrane chemical proportioner controlled by means of an orifice plate interposed in the suction line of the deaerator. Provisions are made for the by-passing of the deaerator in case of an emergency, in which case the removal of dissolved oxygen would be effected by sodium sulphite treatment only.

The diagram below represents the carrying capacity of the pipe line from April, 1934, to November, 1935. This shows the results of periodical cleanings with a "go-devil" as well as the effect of the several methods of treatment used. It will be noted that on April 23, 1934, the capacity was 3.17 million gal. per day. From this date to May 22, when inhibited hydrochloric acid was applied, the average daily loss in capacity was 5,570 gal. per day. The acid cleaning restored 150,000 gal. per day, but its benefits were only temporary, since a further drop followed immediately. A second cleaning in June was followed by still greater losses until a low capacity of 2.2 million gal. per day was reached. This was experienced about the middle of October. By April 2, 1935, when the mechanical deaerator was installed, there was occurring an average daily loss of 18,100 gal. per day, in spite of the various treatments which had preceded this installation.

Maximum delivery capacity of pipe line from Port Sulphur to Grande Ecaille, La., indicating effect of various corrective treatments used from May, 1934, to December, 1935 inclusive


Designed capacity of pipe line
Cleaned all lines except river crossings
Pipe treated with 0.5% HCL
Cleaned 12" line No. 2 and 14" line from Great Bayou to Grand Ecaille
Cleaned from Great Bayou to Washington Bayou
Deaerator put in operation April 2, 1935
Carrying capacity of the pipe line has remained practically constant beyond this point
Cleaned 12" lines from Port Sulphur to Great Bayou
Cleaned from Great Bayou to Ecaille
Clean 12" line No. 1
Sodium sulphite treatment started Nov. 23
Sodium silicate treatment
Lines chlorinated for removal of Algae growth
Delivery in Million Gallons of Water per Day
4.0
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
May June July Aug. Sept. Oct Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov.

Mechanical treatment of the water supply in this manner avoids interference with the water treatment system. This system is located at the power plant at Grande Ecaille and processes water to the high quality required for sulphur mining operations.

Since the apparatus has been in operation, the total decrease in the carrying capacity of the pipe line has been only 36,000 gal. per day over a period of eight months. Recent examination of the pipe lines at several points has indicated that the tuberculation on the surface of the pipe has been almost completely inhibited. It is probable that the carrying capacity loss of the pipe line which now occurs is the result in the change in coefficient of friction traceable to surfaces roughened by corrosion previous to the solution of the problem. There is some indication, also, that organic slimes resulting from the presence of iron-bearing bacteria are partially responsible for existing friction losses. Subsequent measurements not included in this curve show that equilibrium has been practically reached and that further corrosion losses will be negligible.

Results of the operation of this plant for a year have

demonstrated it to be a practical method of inhibiting corrosion of uncoated steel pipe lines, and that such corrosion control is definitely within the range of practical application even for large volumes of cold water.

The total investment in this plant, including engineering, was approximately $12,000, or roughly $3,000 per million gallons per day capacity. The actual operating costs are not definitely established at this time, because depreciation and maintenance charges could not be evaluated in the relatively short time that the plant has been in operation. A recent inspection, however, shows that these items will be minor. Operating characteristics of the deaerator are shown in curves on page 182. Results have been so satisfactory as to encourage the hope that sufficiently complete deaeration in this apparatus may be economically feasible, making possible the elimination of supplementary sodium sulphite treatment and likewise a corresponding reduction in the operating cost.

The authors desire to express their appreciation to the management and especially to W. T. Lundy, vice-president and general manager, whose progressive attitude toward experimentation in a new field of water treatment made possible the ultimate successful solution of the problem. The authors also desire to acknowledge the assistance of the engineering staff of the Freeport Sulphur Co., whose engineering skill and ingenuity were of great assistance in carrying out the experimental work and the designing of the plant.

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[2]Lundy, W. T. "Development of Grande Ecaille Sulphur Deposits" Technical Publication No. 533, Am. Inst. of Mining and Metallurgical Engineers, Feb. 1934.

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Utilization of Soybean Products Increasing Rapidly

SOYBEAN production in the United States has developed from a comparatively unknown crop only a few years ago to one of over 39,000,000 bushels in 1935. The utilization of this new crop has presented a challenge to industry which is being met by increased use of soybean oil and meal in paint, soap, plastics and food products as was indicated in several of the divisional meetings at the recent Kansas City convention of the American Chemical Society.

Solvent Extraction

The oil is obtained from the bean by high-pressure expellers, hydraulic pressing or solvent extraction. The expelling process has been most widely used in the United States, but the solvent extraction processes are making rapid progress as was brought out in a paper by N. T. Spoerri. He describes the Hildebrandt system in which the seed is moved through a U-shaped cylinder through which there is a countercurrent flow of benzine. The solvent can be entirely removed from the extracted meal merely by heating. The oil mixture is cleaned, color removed and the benzine separated by continuous distillation.

According to this author the development of the process of continuous extraction by solvents has resulted in the following advantages over the expeller process: a greater net profit from a larger yield of oil; a smaller production cost; the production of a higher quality of oil; and the production of lecithin from soybean oil. Oil residue in extracted meal is low, maximum 0.8 per cent, whereas the oil residue in press cake is at a minimum of 5 per cent. The price for the extracted meal, even lower in oil content, is the same as for the press cake; hence the greater oil yield is net profit. The production cost by extraction is less because of less labor involved, practically no depreciation or repairs in machinery, the maintenance of little driving power, and less consumption of steam during the actual production period. There is, of course, the elimination of the predrying period necessary in the expeller process. The only loss in production is in the loss of solvent, which under a good extraction system should not exceed 0.6 per cent of the weight of beans processed.

Lecithin Content

By the extraction method, approximately 100 per cent yield of the lecithin content of soybeans can be produced. At present there are available satisfactory solvents and adequate machinery to effect complete removal of solvents from the product.

According to M. M. Durkee, a considerable volume of the refined oil is now marketed as a salad or cooking oil and is blended with 10 to 15 per cent of cottonseed or other oils for use in vegetable shortening. N. F. True reported a survey showing many other uses in food industries such as in bakery and meat products, confectionery, ice cream powders, macaroni products and soy sauces.

Use in Paint

From the standpoint of the paint industry, soybean oil is not an ideal product because of its poor drying qualities, but it does possess excellent characteristics of permanent elasticity and freedom from discoloration. E. E. Ware of Sherwin-Williams stated that the oil is seldom used alone by the paint maker but is either blended with oils of better drying qualities or used as a constituent of a synthetic resin vehicle. It is for this purpose that Ford uses large quantities of soybean oil (see article by R. L. Taylor in this issue of *Chem. & Met.*)

Despite the fact that 124,000,000 lb. of oil was used in soap in 1917, and only 9,000,000 lb. in 1932, very little has been published on this subject according to A. A. Horvath of Newark, Del. He claims that the lathering capacity, which varies with the degree of hydrogenation of the soybean oil used in such soap, is practically unaffected by the hardness of the water—thus making it possible to substitute some domestic soybean oil for the imported coconut and palm-kernel oils.

Significant Developments in Electrochemistry

EDITORIAL STAFF

THE SPRING MEETING of the Electrochemical Society will be held at Cincinnati, April 23-25. This city was selected on account of its favorable location, in an industrial center turning out a large number of products of special interest to the electrochemist and engineer. Prof. H. Kersten of the University of Cincinnati is chairman of the local committee. As the group meets at the time this issue of *Chem. & Met.* is being printed it is only possible to report on the papers that have been preprinted. The news of the meeting will be included in the May number.

One of the principal sessions of the meeting will be devoted to the subject of inhibitors. It will be presided over by Prof. J. C. Warner of Carnegie Institute of Technology. Discharge of electricity through gases at high and very low pressures will be discussed at a session presided over by Dr. J. W. Marden of Westinghouse Lamp Works. A third session will be devoted to storage batteries and will be in charge of R. L. Seabury of the Delco-Remy Corp. In addition, there will be papers on electrodeposition, organic electrochemistry and other subjects.

Inhibitors

Ulich R. Evans, assistant director of metallurgical research, Cambridge University, England, in his paper on inhibitors explains that an attempt to inhibit the anodic reaction of a corrosion-change controlled by the cathodic reaction will usually diminish the corroded area more quickly than it diminishes the total destruction of metal, and thus increase the intensity of corrosion if the addition has been insufficient to stop attack altogether; such methods of inhibition are dangerous. This intensification of attack will not occur where the corrosion is under anodic control, or where the inhibitor is one which smothers the cathodic reaction. The principles are applied in discussing the addition of alkali to hard, soft and saline waters, and also the treatment of brine with chromate. The classification of protective processes into safe and dangerous groups can be extended to protection by oxide-films, paints and metallic coats.

Alkaline plating baths containing ethanolamines are discussed by Prof. C. J. Brockman of the University of Georgia and two of his graduate students, A. L. Brewer and J. P. Nowlen. The production of strike plates from solutions of copper salts containing triethanolamine is compared with those from other solutions. A new solution has been developed which will not plate copper by replacement when brought in contact with iron. This solution will in 70 seconds produce a bright adherent copper plate at 0.4 amp./dm.^{2} capable of taking a subsequent good, adherent copper plate from the commercial acid copper sulphate bath. The solution contains 15 g./L. $CuSO_4$, 5 H_2O, 10 g./L. sodium oxalate and 22 cc./L. triethanolamine.

Another paper presents the results of a study of plating baths for the direct nickel plating of zinc. The following solutions examined contained either just enough triethanolamine to give a clear solution or they contained an excess of triethanolamine: (1) nickel ammonium sulphate solution; (2) nickel ammonium sulphate-nickel sulphate solution; (3) nickel ammonium sulphate-boric acid solution; (4) nickel sulphate solution; (5) nickel chloride solution; (6) nickel ammonium sulphate-nickel chloride solution. The plating conditions of the six solutions were determined at different temperatures, concentrations, and current densities. Current density vs. potential measurements were made during the plating processes.

A copper surface anodically etched in aqueous solutions of orthophosphoric acid becomes as bright as though it had been polished, if voltage and current density are kept within definite limits, according to P. A. Jacquet of Paris, France, who presents a paper on the anodic behavior of copper in aqueous solutions of orthophosphoric acid.

Electrodeposition

The decomposition and equilibrium reaction potentials of fused potassium chloride is the subject of a paper by Roy C. Kirk and W. E. Bradt of the State College of Washington at Pullman. Existing discrepancies in the literature concerning the decomposition potential of fused KCl at 800 deg. C., with graphite electrodes, are reconciled. Professor Bradt and H. B. Linford present a paper on the effect of addition salts on the electrolytic reduction of 3-5-dinitro-o-cresol. And together with another student, H. H. Oaks, Professor Bradt presents the results of a systematic study of the conditions affecting the electrodeposition of manganese from aqueous chloride solutions.

In their contribution on the production of color by electrolysis, Prof. Jesse E. Stareck and Prof. Robert Taft of the University of Kansas state that alkaline solutions of copper lactate produce cathodic deposits at very low current densities (50 milliamp./dm.^{2}) that are highly colored. The color of the deposit is a function of thickness or plating time: violet, blue, green, yellow, orange, red. The deposit appears to be primarily cuprous oxide. It is very stable, both chemically and mechanically, and can be applied to a large variety of metals. The process has been found practical and economical on a commercial basis.

Electrolytic reduction of 2-nitro p-cymene is discussed by Prof. C. A. Mann, Prof. R. E. Montonna and M. G. Larian of the University of Minnesota. J. E. Hatfield and H. R. Harner of Eagle-Picher Lead Co. discuss the effect of certain impurities in the forming acid on plate forming time. And W. G. Parks and I. M. LeBaron of Rhode Island State College report on the simultaneous electrodeposition of thallium and zinc.

Among the other papers that will be presented at the meeting are: Observations on the rare earths by D. W. Pearce, C. R. Naeser and B. S. Hopkins of Purdue University, George Washington University and the University of Illinois, respectively; X-ray permeability of concrete by A. C. Hanson, M. P. Christensen and R. J. H. Cochran of the Rock Island Arsenal laboratory; sound physico-chemical properties of mercursus perchlorate solutions by Prof. Edgar Newberry of the University of Cape Town, South Africa.

Flash Drying for Materials of High Moisture Content

By RICHARD F. O'MARA

Raymond Bros. Impact Pulverizer Co.
Chicago, Ill.

DRYING in one form or another is an essential step in nearly all processing operations. In its broadest interpretation drying may be either mechanical, as in filtering, pressing or centrifuging, or it may be thermal. In thermal drying, the drying may take place in contact with air or combustion gases, or in a vacuum. For the purposes of the present discussion, however, we shall abide by the definition of drying in which moisture liberated by the application of heat is removed by diffusion into a stream of air, vapor or combustion gases.

As will be clear from what follows, drying may be accelerated in various ways. Numerous sorts of drying equipment are available. Some of these are specialized types for handling material in forms which cannot be altered during drying—such as sheets or ceramic shapes. Others used for drying materials of lump or granular character or more or less pasty consistency are able to apply to a considerable degree all of the various acceleration means discussed. Our purpose, then, will be to examine the factors that control drying rate and see how these factors are effectively controlled in the drying method in which simultaneous drying and agitation of the material take place in a current of hot gases.

Drying is chiefly used for producing marketable products. It also has an extensive application in preparing material for other processes or for burning, as in the case of sewage sludge or powdered coal. Where the percentage of moisture is low, the drying problem may not be serious. But as the percentage increases or as the material passes from the lumpy condition to that of a semi-solid, sludge or slurry, the equipment necessary to handle a given quantity of material on a dry basis tends to become bulky and cumbersome. With moisture increase, capital cost rises and the problems of handling and control of feed and the control of moisture content in the final product and cleanliness of the vented air are aggravated. With increasing moisture content, therefore, it becomes increasingly important to seek methods in which fullest advantage can be taken of the factors which increase drying rate or improve drying efficiency.

The chart reproduced in Fig. 1 shows the quantity of moisture contained in sufficient wet material to produce 1 lb. of bone dry material when the wet material contains from 0 to 100 per cent moisture. Thus, for example, with wet material containing 20 per cent moisture,

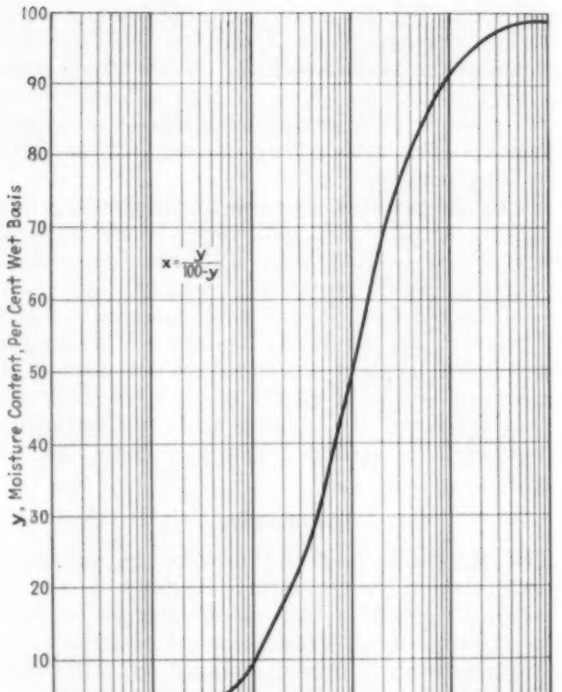

Fig. 1—Pounds of water per pound of dried product contained in materials of various percentages of moisture, expressed on a wet basis

0.25 lb. of water must be removed in producing 1 lb. of dry material. But with material containing 80 per cent moisture, as is encountered in activated sludge, 4 lb. of water must be evaporated for each pound of dry material produced. This increase of 16 times in the required evaporation will reduce the dryer capacity in the same proportion, or to approximately 7 per cent of the original capacity.

Before thermal drying is undertaken it is frequently desirable to remove as much of the water as possible by mechanical dewatering equipment such as screens, filters, centrifugals, dehydrating rolls or presses. Owing to the high specific heat and latent heat of vaporization of water it is far cheaper to remove as much water as possible mechanically than to remove this water by thermal means. In some cases it is an economical step to reduce

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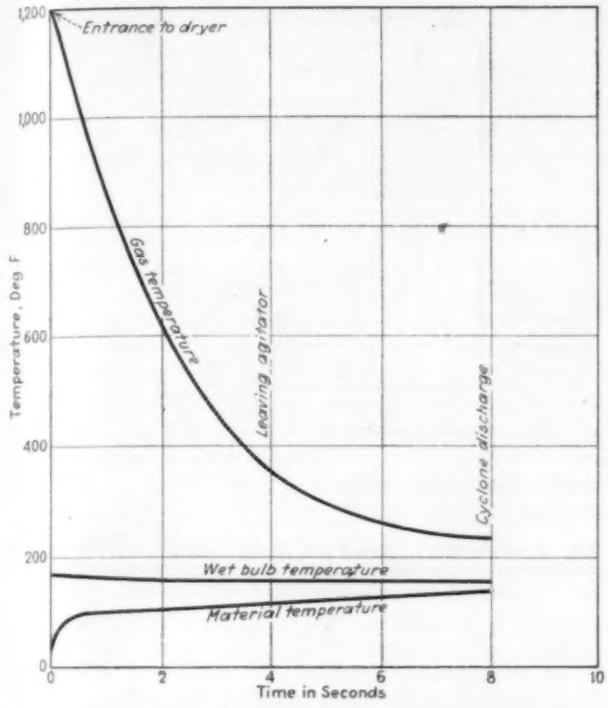

Fig. 2—Diagram portraying temperature conditions of material and drying air in a typical flash drying process

the moisture content in multiple effect evaporators, when they can be used. This is becoming common practice in the disposal of distillery slop. Although multiple effect evaporation requires more energy than mechanical dewatering, the latter method cannot always be employed.

When the material has been dewatered to the lowest practical limit, the next step usually is the employment of an air dryer to remove the residual moisture and produce a dry solid suitable for marketing or other use. In all processes where high moisture content is encountered, the best combination of dewatering and drying equipment should be sought, such as the application of a thickener, followed by a filter and a dryer.

It was mentioned above that there are a number of factors which can so be manipulated as to accelerate drying rates. These four factors, which control the vaporization of moisture from wet materials, are surface, agitation, vapor pressure potential and velocity of the drying air. In all drying processes, so far as possible, either consciously or unconsciously, we attempt to control these conditions to the greatest advantage.

As a simple example, take the case of drying one's hand. Lacking a mechanical method of dewatering such as a towel, the hand is first dewatered as far as possible by shaking to remove extraneous moisture, thus reproducing the action of a centrifugal. Then the two hands are rubbed together, thus increasing the surface by spreading the moisture out over a larger area. This rubbing also has the effect of agitating the moisture and thus reducing the thickness of the vapor film, while at the same time, both from the air and from the body, heat is flowing to the moisture to supply the latent heat necessary to evaporate it. As the water evaporates into the surrounding air, evidence of the evaporation may be noted in the feeling of coolness produced. As a final means of completing the evaporation, the hands are waved in the air, thereby creating a velocity of air passed the surface, not only scrubbing away a part of the moisture film, but also bringing the hands in contact with new air, having a lower partial pressure of water than the vapor pressure of the water on the hands.

This is a homely example, but it indicates what must be done in securing high air drying efficiency. The rate of evaporation is directly proportional to the surface exposed, also depending directly upon the difference in temperature between the drying medium and that of the material to be dried. The rate of heat flow depends not only on this temperature difference but also upon the velocity of the air past the material, the turbulence of the air in contact with the material and the agitation of the material or the production of new surface. Diffusion of moisture from the material into the air must take place through the material to the surface, through the vapor film on the surface and from the film to the surrounding air. By comparison with the first and last resistances, the resistance of the vapor film is by far the largest and it is in reducing this film as effectively as possible that some of the most important improvements in drying can be secured.

The first of the factors, surface, may be improved in various ways, such as by spreading the material out on trays or drying beds. In other types of dryer the surface is increased by forcing the material out through small orifices, or by injecting it into the drying chamber by means of sprays or mechanical atomizing devices. Surface can also be created by spreading the material out in a thin layer on a roll as is done in drum-type dryers. One important method of increasing surface area is to mix a part of the already dried material with the wet feed. Still another method is by grinding or disintegrating the wet material while it is in the drying zone.

The creation of additional surface has two important effects. The first is to minimize the resistance to the diffusion of moisture from the interior of the material to the surface. By creating new surface, the moisture which would otherwise be contained deep down in the material is brought relatively close to the surface or actually on to the surface. The second effect of this factor is that increasing the surface increases the area from which moisture can evaporate. In the case of a dryer increasing surface by means of disintegration it is possible to produce very small particles and enormous surface. This follows from the fact that the ratio of surface area to volume increases inversely as the diameter of the particle. As a concrete example, assuming spherical particles, material broken down to 100-300 mesh will present 90-275 times as much surface per unit volume as will particles of $\frac{1}{2}$ in. diameter such as are encountered in rotary dryer feeds.

The second factor, agitation, is one that is closely tied up with the creation of new surface. If this surface is created by some mixing or disintegrating action, then the material will be agitated with respect to the air. Such agitation has the effect of reducing the thickness of the vapor film on the surface of the material, thus increasing the rate at which heat can pass from the surrounding air into the material. So long as adequate surface is presented and sufficient turbulence is maintained, the temperature of the wet material, while it contains more than the equilibrium moisture content, cannot be increased

above the wet bulb temperature of the air. This has certain advantages, particularly in the case of materials which might be injured by excessive temperature, and materials which tend to case-harden. So long as water diffuses through the material faster than it can be carried away from the vapor film, there can be no tendency toward case hardening of the surface of the material. When case hardening occurs, further escape of moisture is prevented except under excessive application of heat.

Neither the production of fresh surface nor the employment of turbulence is of much use, however, unless a potential exists between the vapor pressure of the moisture within the material and the partial pressure of the water in the drying air. Surface and agitation provide means for reducing the various resistances encountered by the water in vaporizing from the material, but it is the vapor pressure potential which causes diffusion of the moisture into the air. This potential may be regarded as similar to an hydraulic head or an electromotive force in that it causes flow from a region of high to a region of low potential. The higher the temperature of the air, relative to the temperature of the material, the higher will be the potential and the greater the quantity of heat available for latent heat of vaporization of the moisture.

Where it can be used, high temperature of the drying air is advantageous for it makes possible much greater capacity for a given drying equipment. The term "high temperature," of course, refers to the temperature of the air since the material temperature is, or should be, much lower. For example, temperatures as high as 1,600 deg. F. are used in the drying of orange pulp, although the pulp itself would burn at a much lower temperature. In another instance, a material which would scorch at 130 deg. F. in a tray dryer is being dried in high velocity air at 200 deg. F.

High Air Velocity Reduces Film

The fourth of the factors controlling drying rate, air velocity, has much the same effect as agitation in that the air exerts a scrubbing action on the vapor film in contact with the material and assists in reducing its thickness. As Sherwood shows (Perry's "Chemical Engineer's Handbook," p. 1223, McGraw-Hill, 1934), evaporation of moisture is influenced directly as the 0.8 power of the mass velocity of the air. In view of this relation, the importance of using as high an air velocity as possible cannot be over-rated. In dryers employing velocities in the order of 3,000-4,000 ft. per min., the evaporation rate will be two to three times that where the air velocity is in the order of 1,000 ft. per min.

A typical performance curve of a dryer employing high temperatures and velocities is shown in Fig. 2.

A type of equipment which has been given the trade name of flash dryer, designed to produce the optimum drying conditions according to these standards, has been in operation now for several years, drying numerous high moisture materials and wastes, such as fruit pulp, sewage sludge, waste distillery slops, as well as coal and other granular materials and chemicals. Such equipment is employed not only in the removal of free moisture, but may also be used in removing chemically combined water as in the calcining of copper sulphate and gypsum. For many purposes, such equipment has proven very effective. With generally high efficiency, it is adaptable to close control. On the other hand it has certain limitations in that the final products can only be produced in a disintegrated state. In some cases agitating equipment is employed to break the material down to its original particle size. In others, actual grinding is accomplished to reduce the particles to even smaller units than existed in the dryer feed.

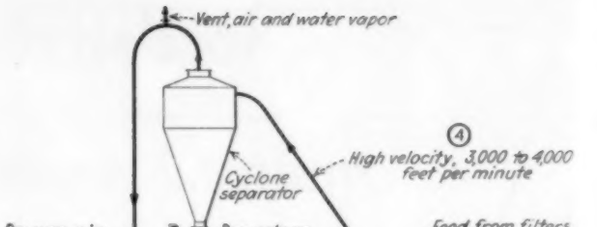

Fig. 3—Schematic layout of flash drying installation indicating at numbered points where factors controlling drying rate are introduced into process

Fig. 3 shows diagrammatically such an installation. Keeping in mind the fundamentals outlined above, following through the construction and operation of this equipment, it will be clear how optimum conditions from the standpoint of the several drying factors have been maintained. Wet material is generally first dewatered on a filter, centrifugal or other mechanical appliance, and then is often mixed with some of the previously dried material so as to spread the water over much greater surface area. Some amorphous materials and most crystalline materials can be fed directly into the drying equipment and the surface created by the disintegrating action of a hammer or cage mill. Owing to the very short time that the material remains in the process, 2-12 seconds, definite control of the final moisture content and of the maximum temperature to which the material itself rises, can be maintained.

As the wet material, or material which has been mixed with some of the previously dried material, enters the apparatus, it is dropped into a high temperature air stream, and carried with it into an agitating, or in some cases, a grinding chamber where it is subjected to an enormous increase in surface at the same time being violently agitated in contact with the air. The factors of surface increase, agitation and high air velocity then greatly reduce the thickness of the moisture film next to the particles, permitting ready diffusion of the moisture to the surface and into the air stream. Materials which otherwise might be injured by heat may be dried in this manner owing to the fact that the temperature of the material itself rarely goes above the wet bulb temperature of the air. In fact, should the material temperature be higher than that of the wet bulb of the air, it may

actually be cooled during the drying owing to the refrigerating effect of the evaporation.

The effect of high air velocity on the drying is somewhat similar to what occurs to powdered coal as it is burned in a furnace. It is well known that in order for the combustion to be complete, the CO_2 film surrounding the coal particle must be scrubbed as thin as possible in order that fresh oxygen may be brought in contact with the particle and so complete its burning. By analogy, unless the moisture film is made as thin as may be, so that new air having a lower vapor pressure may come in contact with the material, drying cannot proceed rapidly.

Even where materials that are not heat sensitive are dried, low material temperature may be of considerable advantage as in the case of sewage sludge which tends to create odors should the temperature of the material be increased to any considerable extent. In this case it is possible to employ inlet gas temperatures of 1,200-1,400 deg. F. without increasing the material temperature to more than 150 deg. F.

Leaving the grinding chamber, the material is carried in suspension by air and delivered to a separator in which the solids are removed from the stream of vapor-laden air. Part of the air may be returned for diluting the combustion gases, the quantity depending upon the requirements of the particular process.

Table I—Drying Results Attained With Typical Flash Dried Products

Material	Dewatering Equipment	Moisture Percentage, Wet Basis Entering Dryer	Leaving Dryer
Chlorine powder	Filter	...	...
Chrome green	Leaf filter	25	0.1
Clay (acid treated)	Filter	60	8
Cooked blood	Press	80	5
Copper sulphate	Centrifugal	...	Monohydrate
Diatomaceous earth	.....	45–60	2–6
Distillery slop			
Grain	Screen		
Syrup	Evaporator	57 avg.	7
Sludge	Centrifugal		
Garbage	.....	85	7
Gypsum	.....	20–22	4–5
Hemp pulp	Filter	90	10
Milk albumin	.....	50–60	5–6
Orange pulp	Press	82	4–10
An organic compound	Centrifugal	50–53	14
Rye culture	.....	35	8
Sewage sludge	Filter	82	4–10
Sodium sulphite	Centrifugal	50–52	0.01
Starch	Filter	42	7
Steamed bone	Press	40	5
Sulphur concentrate	Filter	25	1.5
Synthetic casein	Filter	80	7
Tannins	Filter	60	3
Waste yeast	Leaf filter	60	5

It is clear from the diagram and this discussion that the flash type dryer takes the fullest possible advantage of the several drying factors. Extremely high moisture content may readily be reduced to a low figure as from 80 per cent in the feed to 5 or 8 per cent in the discharged material. The process is flexible and readily capable of handling combinations of material such as a combination of wet distiller's grain and sludge from extractors having as high as 80 per cent moisture, plus a syrup from evaporators containing 50 per cent moisture.

Although flash drying takes account of all of the several drying factors, leading to rapid and efficient moisture transfer, the resulting thermal efficiencies vary over a wide range. This variation is caused by the difficulty with which various materials can be induced to give up their moisture content. This difficulty does have a considerable effect despite the fact that agitation or disintegration during the drying process tends to minimize the effect of coefficient of diffusion of moisture through the material. With a well insulated system, thermal efficiencies of 1,750-1,500 B.t.u. per pound of water are common. In processes in which the drying is carried to a point of removing water of crystallization, the thermal efficiencies are somewhat lower owing to the higher temperatures necessary for initiating and continuing the calcining operation. In such operations, efficiencies of 3,000-1,900 B.t.u. per pound of water are obtained.

By the addition of suitable classifying devices such as screens or mechanical air separating equipment, an installation of the type described is capable of producing products of definite particle size, containing a specified moisture content and operating on a continuous basis. Thus, in one integrated group of appliances, it is often possible to carry a product from the point of high moisture content to a condition where it may be delivered directly to the packaging equipment ready for sale to the customer. The accompanying tabulation lists a few of the materials that have been dried by this means, showing what equipment has been used for preliminary dewatering and the range between initial and final moisture content.

Eliminating Sulphur Dioxide Hazard in Air Conditioning

ACCORDING to the results of tests recently announced by the Virginia Smelting Co., West Norfolk, Va., what little hazard to life may exist in the use of sulphur dioxide as a refrigerant in air conditioning installations may be readily overcome in systems employing air washers through the use of certain alkaline solutions instead of water in the washer sprays. It has been recognized for some time that the corrosion that may occur in the air washers and associated equipment, owing to the absorption of atmospheric acidic gases, may be overcome by using washer solutions of a pH of about 8.5 or more, provided that the chemicals added to the water exhibit film-forming characteristics. On this score it has been claimed that NaOH alone should not be used, but that sodium dichromate or chromate should be added. On the other hand, in one large installation, sodium hydroxide alone is reported as satisfactory and at the higher concentrations recommended by the Smelting company, no corrosion has been found.

To avoid the possibility of health hazard, the recommended procedure is to install the refrigeration unit and brine cooler in an isolated part of the building so that any loss of SO_2 can be vented without its entering the occupied portions of the building. The brine (washer solution) may be any desired concentration of NaOH, with chromate or dichromate added if desired. Should a leak of SO_2 occur within the brine cooler, the gas will then be completely absorbed by the brine, and will not again be released to the air stream in the air washer. In proof of this, it was shown that 40 lb. of SO_2 could be released in less than three minutes into a system containing 400 gal. of a solution of NaOH, containing 0.1-0.33 lb. NaOH per gallon, without permitting the escape of any appreciable SO_2 to the air passing through the washer.

The same method, it has been suggested, could be used with multiple-unit refrigerating systems, such as are often used in apartment houses. The brine circulated could either be straight NaOH brine, or a brine containing sufficient NaOH in addition to the usual $CaCl_2$ to absorb the SO_2 in the system.

Vacuum Producing Equipment For Chemical Plant Use

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EQUIPMENT for producing vacuum is generally regarded by the chemical engineer as a necessary evil, perhaps even somewhat mysterious. Either as the cause of this attitude, or resulting from it, until lately the problem of maintaining a vacuum in chemical equipment has been largely neglected. When vacuum equipment has been overdesigned, at slight additional initial cost as compared with that of the equipment it is to serve, it operates satisfactorily and nobody knows the extent of the overdesign. But when it has been underdesigned, its importance is suddenly magnified. More than once a set of vacuum pumps or a barometric condenser, wrongly designed, has caused trouble both to the user and the designing engineer.

More frequently, in the writer's experience, however, the underdesign of one part of the equipment will be offset by the wasteful overdesign of another part. Barometric and jet condensers and steam jet air pumps were developed primarily for use in the steam power plant. Steam jet air pumps are a fairly modern development and although they have been the subject of much research, resulting in great improvement in economy and operating characteristics, this knowledge is kept strictly guarded by a relatively few manufacturers.

A literature search would yield the layman little of value in this connection. Barometric and jet condensers were developed for the steam engine primarily. The design data available are largely related to engine performance; the required vacuum, the quantity of non-condensable gases to be handled and the economy in water consumption impose far less stringent requirements on the capabilities of the apparatus than are encountered in many chemical engineering applications.

In order to maintain a vacuum on any system, it is necessary continuously to remove the vapors and gases evolved in the system or entering it from the outside. It would, of course, be possible to do so by pumping them entirely from the system, but it is less expensive to condense the vapors as far as possible, at the prevailing vacuum, and remove the vapor-saturated gases by means of a suitable pump. It is important for the designer of any vacuum system to remember that pumping vapors and gases from high vacuum to atmosphere is the most expensive pumping process known.

The difficulty of maintaining a vacuum depends both on the degree of vacuum to be produced and the quantity of non-condensable gases evolved. The latter may be truly non-condensable—as air entering through leaks, or dissolved in the materials entering the process—or, from the practical standpoint, they may be process materials which do not condense under the conditions of operation. Some vacuum applications are comparatively simple in that a low vacuum may be employed or that the quantity of non-condensables is small. In such cases an ordinary surface condenser and combination wet and dry vacuum pump may be satisfactory, or an entrainment type of jet condenser may suffice. But it is with the more severe conditions, such as those met in vacuum distillation and evaporation that the present article is largely concerned.

Maintenance of high vacuum in chemical equipment is practical when the bulk of the material to be condensed has a low vapor pressure at the available water temperature and when the quantity of non-condensable gases and vapors is not too large to be pumped economically from the system. For example, vacuum distillation is now used to a large extent in petroleum refining. Fig. 1 represents a typical vacuum distillation unit, including a vacuum fractionating tower, a surface condenser, barometric condenser and a two-stage steam jet air pump or ejector. The overhead distillate is mixed with process steam and has a considerably lower vapor pressure than water. It is therefore possible to condense the oil in the surface condenser, while the steam is condensed sepa-

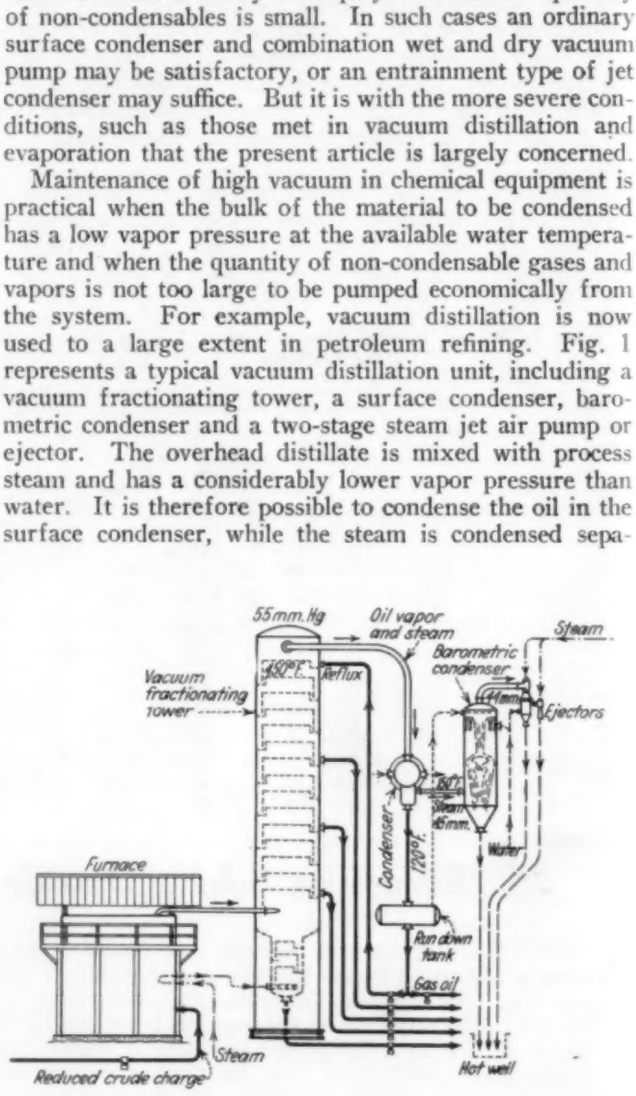


Fig. 1, Above—Vacuum distillation unit showing condensers and steam-jet vacuum equipment

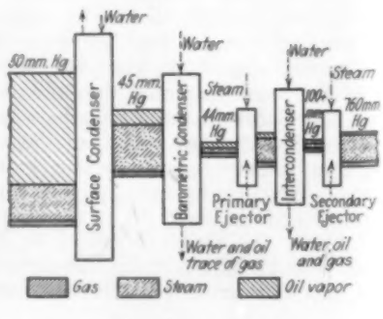


Fig. 2, Right—Graphic illustration of vacuum condensation in the system of Fig. 1

rately in the barometric. The non-condensable gases are removed by the ejector, which can maintain an absolute pressure of 40-50 mm. at the ejector inlet. The non-condensable gases consist of air and gases and a small quantity of oil vapor leaving the surface condenser. In a unit of this type, the absolute pressure on the system is determined by the vapor pressure of the steam condensing in the barometric condenser.

The requirements for maintaining a vacuum in this system, i.e., continuous condensation of vapors and removal of air, are illustrated in Fig. 2. A successive condensation, accompanied by pressure drop, occurs toward the ejector inlet. At this point, the lowest absolute pressure in the system exists. From this point on, the absolute pressure is raised to atmospheric at the expense of live steam. The ejector intercondenser condenses the exhaust, and much of the primary ejector load. The primary ejector controls the vacuum. Its capacity is the neck of the bottle. The circulating water temperature and the vapor pressure of the oil only influence the vacuum in so far as they influence the ejector load and the pressure drop up to the ejector inlet. As already noted, with a large enough ejector, no condensers would be needed to maintain a vacuum, the condensers being used to reduce the size of the air pump to a minimum, and to recover the products easily.

A steam jet ejector element is shown diagrammatically in Fig. 3. It consists essentially of a steam nozzle, air chamber and diffuser piece. Steam expands through the nozzle, issuing at a high velocity. This entrains the gases admitted to the diffuser throat and imparts velocity to them by impact. This kinetic energy is converted into pressure by the diffuser, which increases in area and reduces the velocity.

The fundamental principle in the design of ejectors is the proper location and arrangement of the nozzles so as to get an effective impact of the steam with the gas to be pumped. The use of multiple nozzles to give a high contact surface of steam and air is often practiced. The length of the diffuser, its shape, and the nozzle location with respect to the throat are very important. Manufacturers of ejectors are forced to use expensive trial and error methods to acquire this knowledge, and very little information is published. In purchasing ejectors, surprising differences of guaranteed steam consumption may sometimes be noticed, because, no doubt, of the generally undeveloped state of the art except among a few manufacturers.

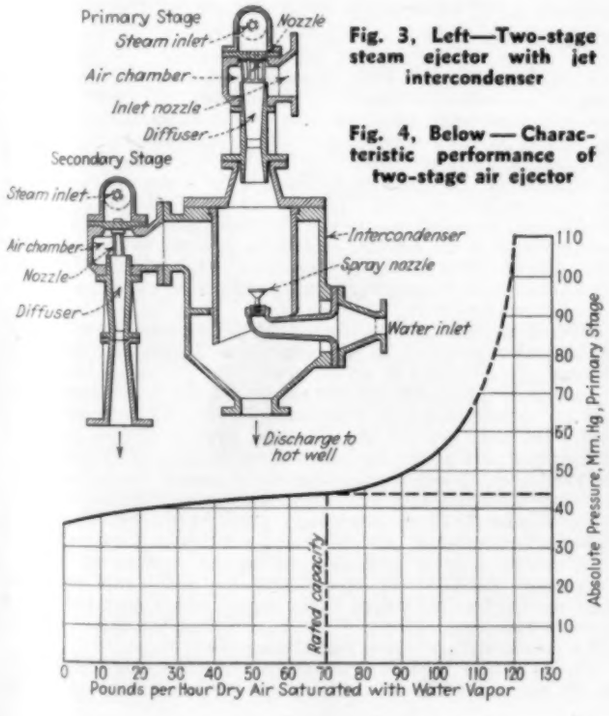


Fig. 3, Left—Two-stage steam ejector with jet intercondenser

Fig. 4, Below — Characteristic performance of two-stage air ejector

Characteristics of Ejectors

A steam nozzle operates best over a definite pressure drop. A change of initial pressure causes diffusion of the issuing jet of steam, resulting in eddies and a loss of energy. In a steam jet ejector, this effect is pronounced because of the resulting inefficient impact and entrainment of the gas to be compressed. Consequently a change in pressure of the steam, particularly a drop in pressure, greatly upsets the operation of an ejector. A drop of 10 per cent below designed initial pressure will usually cause an ejector to stop functioning altogether and the vacuum to be lost, sometimes under conditions which are apt to be dangerous, as when air is drawn back into a tower containing hot, flammable vapors.

It is necessary, then, to insure a steady boiler pressure, and to select the ejector to operate on steam at a pressure 20 to 30 lb. below boiler pressure. A reducing valve can then be used to maintain steady steam on the ejectors, even though the boiler pressure may fluctuate.

It may be noted, then, that an ejector cannot be throttled. A characteristic of all nozzles having a drop below the critical pressure is that the weight flow depends only on the upstream pressure. Hence the steam consumption of an ejector depends on the absolute pressure of the live steam. If an ejector designed for steam at 85 lb. is supplied with 95-lb. steam, the steam consumption is $(95+15)/(85+15)=1.10$ times the guaranteed quantity. This additional steam will, however, carry little additional load because of the lower nozzle and throat efficiency. Any attempt to reduce the steam consumption by throttling will result in a loss of vacuum. It is therefore advisable to install two or three batteries of ejectors so that one may be shut off under light load.

Fig. 4 shows the characteristic of a two-stage steam jet air pump. Reducing the load does not greatly improve the vacuum. Considerable overloading will cause a rapid loss of vacuum. Thus a unit closely designed might experience serious fluctuations of absolute pressure, if, for example, the amount of gas increased due to uneven furnace conditions, or water temperatures increased due to tidal conditions. This tendency of ejectors suddenly to drop the load has often mystified operators.

For most vacuum distillation units, two-stage ejectors are used, as illustrated in Fig. 3. The actuating steam and condensable material from the first stage are condensed in the intercondenser. It follows that, if the first stage handles a large amount of condensable vapors, the second stage may be of smaller capacity. When the quantity of vapors which may be condensed in the intercondenser is known to the ejector manufacturer, he is in a position to quote a more economical arrangement than if the total load is specified on a "dry-air" basis.

For most vacuum distillation units, few data are avail-

able concerning the quantity of dry gas which it is necessary to handle. Unlike steam condensers this quantity ordinarily will not depend largely upon leakage. The author has seen oil distillation systems containing 5,000 cu. ft. leak air at the rate of only 6 lb. per hour, yet in operation they delivered upwards of 80 lb. per hour of non-condensable gases. In general, light ends in the feed, and more especially cracking of the charging stock, produce most of the gas. For oil distillation, from 25 to 60 lb. per hour of 30-mol weight gas per thousand barrels of feed per day should be allowed in rating ejectors. Direct reference to a similar unit which has operated successfully should be made wherever possible. At the present stage of development, experienced gambling is usually the only known method of estimating the required ejector capacity. In no case should the total load be considered as dry gas. It may be that the failure even of manufacturers of ejectors to appreciate this fact accounts for the large discrepancies in steam consumption encountered with ejectors of different manufacturers.

As has been noted, the basic element of any vacuum producing apparatus is the ejector or other vacuum pump. A large enough ejector would function without a condenser. The aim in designing all vacuum equipment, however, is to reduce the size of the required ejector to a minimum. The primary purpose of a vacuum condenser is to reduce the condensables in the non-condensable exhaust with as little pressure drop as possible. A direct contact steam condenser should always be considered in this light, and the absolute pressure at which a system is run should be selected with this in view.

Direct contact or mixture condensers are usually used for condensing process steam, since very large surface condensers would be required for this work. The countercurrent barometric type of jet condenser is employed, since with it, pumping costs are at a minimum and, more important, the countercurrent principle reduces the required air capacity.

In Fig. 5 are shown two hydraulic arrangements of mixture condenser. That at the left is a low level jet condenser. This type rests directly on the ground and water is pumped from the condenser against atmospheric pressure. The injection water is drawn in by the vacuum. Obviously this pump must work under a head of about 30 ft., depending on the vacuum. The sketch at the right shows a barometric condenser, a type which must be elevated to such a height that the water can discharge from the barometric leg. Water at atmospheric pressure will rise to the height *A*, about 33 ft. The distance from this point to the water inlet represents the pumping head required, usually 10-15 ft.

Another striking difference between the two arrangements shown is the direction of the steam flow. By using the parallel flow arrangement of the turbine condenser, in which the coldest steam-air mixture meets the hottest water, great advantages in equipment arrangement are obtained in this application. This arrangement results, however, in a high degree of saturation of the air leaving the condenser, necessitating an external air cooler for large condensers. With countercurrent steam flow, as in the barometric condenser, the coldest vapor meets the coldest water. When large quantities of non-condensable gas are present in the steam, as most chemical engineering applications, the countercurrent condenser must be used.

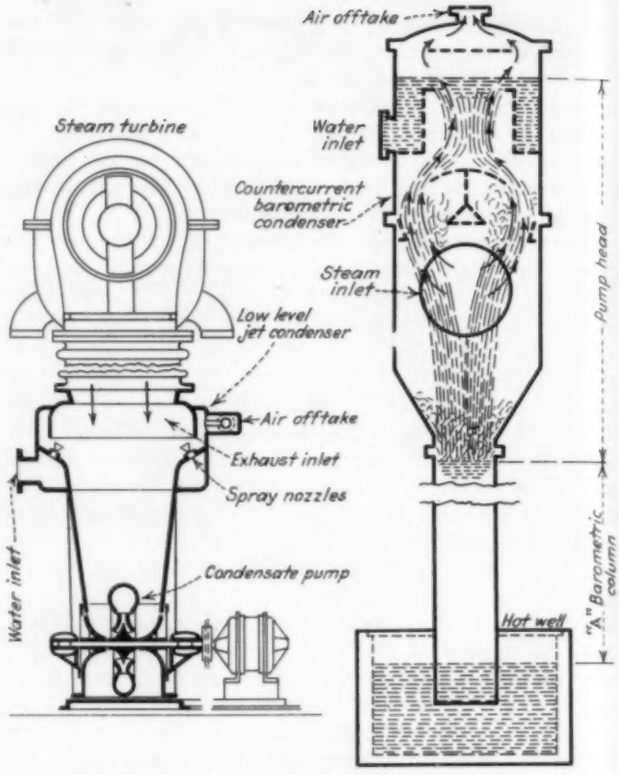


Fig. 5—Two types of mixture condenser, that at the left a low-level jet condenser, with a barometric condenser at the right

There are three characteristic designs of barometric condenser on the market, as illustrated in Fig. 6. Type *a* is typical of "pressure drop" condensers in which high vapor velocities are employed. It is usually offered with considerably less height and weight and a much better approach guarantee than Type *b*. When it is overloaded with non-condensables the pressure drop greatly increases, with oftentimes little change in the gas outlet temperature.

Type *b* operates with little or no pressure drop. The writer has seen these condensers operate with no noticeable deflection of a kerosene manometer connected between the steam inlet and the air discharge. When a condenser of this type is overloaded, the gas discharge temperature rises, and more condensables are carried to the ejector. The absolute pressure in the system rises owing to the increased ejector load. Type *b* has the disadvantage that the ejector load may increase to the "breaking point" on the characteristic curve of the ejector, causing the ejector to cease to function. On the other hand, an overloaded job can be fixed by adding an additional barometric as an external air cooler or by adding additional ejectors.

With Type *a* it is very likely that the pressure drop will increase under overload to a point where additional ejectors or external air coolers will do no good. On the other hand, with Type *b* it is inherently difficult to get a large water surface per unit of volume, unless a complicated hydraulic arrangement is used. In some designs of this type, several slotted trays are so arranged one above the other as to produce a dense rain in the condenser, through which the steam passes. Another device is to use "disk and doughnut" pans with many small holes drilled in the bottom. These condensers give, in theory, very much higher effective water surface than most conventional types, but often rapidly plug up with dirt and become ineffective.

However, the writer has seen a condenser of this type, in service some months on Mississippi River water, which operated with a terminal difference of 5 deg. F., an approach of less than 1 deg. F., and a pressure drop of less than 1 mm. Hg.

We are at once led to another method of classifying barometrics, i.e., by the method in which the water surface is exposed. Type

b shows the use of umbrellas and circular weirs to give a conical sheet of water. Such sheets must be broken to permit the steam to enter, otherwise they will be unstable. The angle piece *A*, in Fig. 6*b* is a valuable patented feature of this condenser, for it makes possible stability of the water curtain. Condenser *a*, on the other hand, makes use of a series of circular notched weirs which give a rain in the condenser.

A spray design using a non-clogging nozzle is shown in Fig. 6*c*. The unique feature of this condenser is that a series of orifices is used to "shave" off cylindrical sheets of water from the rising jet. The steam passes through the very thin, stable, high velocity films of water, and good contact is obtained. This condenser operates satisfactorily when out of plumb.

The methods of *a* and *b* require height in a condenser to give surface. When water is discharged in streams or in films, as from a weir, the velocity of the water increases as it falls, the stream contracts, and less and less area per foot of height is presented the further it falls. A rain likewise gives less effective surface per foot of height the further it falls, since the distance between drops increases. Likewise, surface temperature of the droplets is rapidly raised, but owing to lack of turbulence and low thermal conductivity, the heat does not penetrate toward the center. Hence frequent interruptions of the fall of the water increase the effectiveness of the condenser in two ways; by increasing the exposed water surface, and by causing turbulent mixing at frequent intervals.

The most effective way in which to increase the water surface is to spray the water. This device is used in most power condensers because of the limited space available. The use of ordinary spray nozzles has the disadvantage of considerably increasing the pumping head and being sensitive to debris in the water.

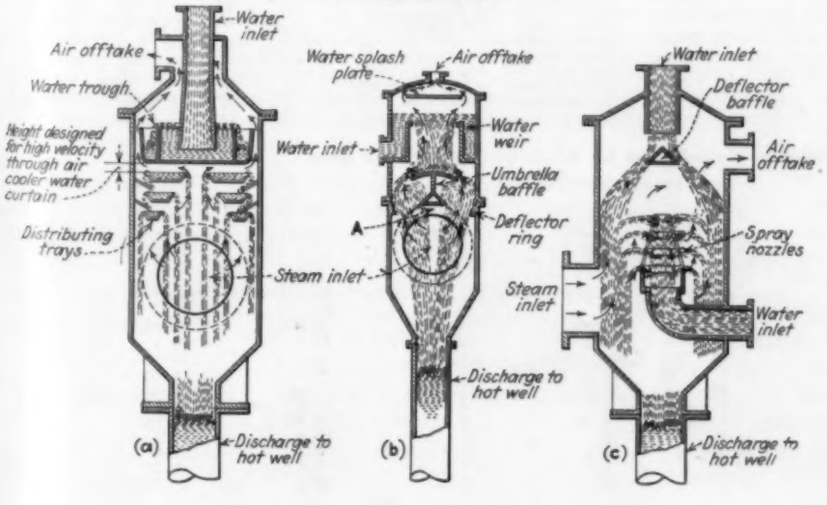
The problem of barometric condenser design looks easy. The average layman believes that steam condenses instantaneously upon contact with water. Unfortunately, this is not true. Time is required for condensation and it is necessary to consider the problem as one in surface heat transfer and attempt to calculate the heat transfer rate and the surface required. If we plot the temperature of water and steam versus the surface, as in Fig. 7, we obtain a picture of the problem. Owing to the presence of non-condensable gas, the steam and gas mixture drops appreciably in temperature. The difference in temperature between the entering mixture and the outlet water (*A*) is known as the "terminal difference." The difference between gas outlet and water inlet (*B*) is known as the "approach." These two values are important and interdependent. The smaller (*A*) can be made for a given discharge water temperature, the lower may be the saturated steam temperature and the possible absolute pressure. The smaller *B* can be made, the less the quantity of water vapor carried to the primary ejector. These two temperatures are considered, in the trade, as the criteria of performance of a barometric condenser. Incidentally, in condenser design, the correct temperature to use is the weighted *mean*, never the log mean temperature difference. But in dealing with condensation problems, it is better to speak of the mass transfer of the vapor rather than the heat transfer. The overall heat transfer rate is controlled both by the rate of diffusion of vapor to the water surface and by the thermal resistance of the water. The second effect is the controlling factor for a fairly pure steam, as in a power condenser. The first controls when the quantity of non-condensable gas is high.

The quantity of steam condensed per unit time is proportional to the mass transfer coefficient, *K*, the contact area between steam and water and the mean difference between the partial pressure of the steam and the vapor pressure of the water. It can be seen that if the water is hot at the surface and cold in the center of the stream, the mass transfer rate, *K*, will be reduced. This happens when the steam is very pure and the water side rate becomes controlling.

The value of the mass transfer coefficient, *K*, at any point in the condenser is directly proportional to the mass velocity and hydraulic radius and inversely proportional to the partial pressure of the non-condensable gas. This last factor is uncontrollable in the design of a barometric condenser but is often controllable in the design of the process.

Increasing the mass velocity is a practice which often results in a pressure drop in the condenser, partly defeating the purpose of a low approach. However, at the outlet end of the condenser the partial pressure of non-condensable gas is so large that the mass transfer rate becomes very small if only natural convection velocities prevail. Colburn and Hougen give, for an air and steam mixture under conditions of viscous flow, the value $K=2.36/P_g$. At the condenser inlet P_g, the partial pressure of the non-condensable gas, may be 1 mm. or less. The controlling resistance is then undoubtedly on the water side. At the outlet P_g may be 30 mm. or more. It is therefore necessary to follow one of two courses in design, either: (1) Take a pressure drop, using high vapor velocities, particularly at the cold end of the condenser; or (2) greatly increase the physical proportions and the exposed water surface in the condenser. The area of the exposed water surface in a condenser depends upon the quantity of water, the extent of subdivision and the time in the condenser. The problem in good design is to produce the maximum exposed water surface and the maximum heat transfer rate with the least expenditure for equipment and water.

Fig. 6—Typical barometric condensers: (a) condenser with restricted vapor flow area; (b) condenser with large vapor flow area; (c) condenser with non-clogging spray



The actual mechanics of condensation may be described as a migration of vapor molecules from a region of high partial pressure existing in the main stream of the gas and vapor mixture, to a region of low partial pressure, existing on the surface of

the water in the condenser. The rate of transfer of particles is directly proportional to the partial pressure difference existing between these two regions—not the temperature difference. For conditions of turbulent flow the mass transfer rate has been expressed by Colburn and Hougen as follows:

$$K = 80\frac{V^{0.8}F}{M_g^{0.5}P_g}$$

where V = mass velocity in pounds per second per square foot; P_g = partial pressure of the gas in millimeters of mercury; M_g = molecular weight of the gas; F = an "entrance factor," assumed to be 1.5 for direct contact condensers = $1-1.6\times10^{-0.1N}$ for tubular condensers; N = ratio of length of tubes to outside diameter; and K = mass transfer coefficient in pounds per hour, square foot and millimeter of mercury.

Let us now consider a typical problem. It is required to handle in a barometric condenser 5,000 lb. of steam per hour, containing 100 lb. of gas of 30 mol weight (3.33 mol), using condenser water at 70 deg. F. and maintaining an absolute pressure of 40 mm. Hg. Assuming a terminal difference of 5 deg. F., and with 93 deg. F. saturation temperature of the steam at 40 mm., the outlet water temperature will be 88 deg. F. and the rise in water temperature, 18 deg. F. The heat content of saturated steam at 40 mm. is 1,101.4 B.t.u. per pound and of water at 88 deg. F., 56.0 B.t.u. per pound, so the heat to be extracted from the steam will be 1,045.4 B.t.u. per pound or 5,000 × 1,045.4 = 5,230,000 B.t.u. per hour. In cooling the gas to an assumed exit temperature of 73 deg. F., 100 (93—73) 0.50 = 1,000 B.t.u. must be absorbed by the water. This is negligible and can be omitted from the calculations. The quantity of water required then, will be 5,230,000/18 = 290,000 lb. per hour.

At 93 deg. F. the specific volume of the steam is (359/18) (760/40) (460 + 93) / 492 = 426 cu.ft. per pound. Assuming an initial velocity of 25 ft. per second the mass velocity becomes 25/426 = 0.0582 lb. per square foot. The flow of steam is 5,000/3,600 = 1.388 lb. per second so that the flow area corresponding to the assumed mass velocity is 1.388/0.0582 = 23.8 sq.ft. or 5 ft. 6 in. in diameter. At this velocity the flow will be viscous as soon as condensation sets in. Hence $K = 2.36/P_g$.

It is now possible to proceed with the calculation of the condenser. We know how much water must pass through the condenser per hour to condense the steam supplied to it, but we do not know how much water surface must be exposed to the steam to effect the necessary transfer of vapor to the water stream. As has been pointed out, the rate of transfer at any point will depend upon the difference in partial pressure at that point in the condenser, and this difference will vary from point to point, depending on the water temperature and the percentage of steam remaining in the vapor. It is necessary, therefore, to divide the condenser into a number of zones, each sufficiently small that average conditions can be assumed to maintain. In the lower part of the condenser where the bulk of the condensation takes place it may safely be assumed that the vapor temperature will remain constant at 93 deg. F. It will be convenient to consider that 60 per cent of the condensing takes place in three constant temperature zones, in each of which 20 per cent of the steam is condensed. In each of these zones the partial pressures of gas and steam can be calculated from the average quantity of steam flowing. The average water temperature can be calculated from the assumed terminal temperature and the quantity of heat extracted. The mass transfer coefficient can be determined from the formula, $K = 2.36/P_g$, and the vapor pressure of the water from its average temperature. The pounds condensing per square foot per hour is then calculated as the product of the coefficient, K, and the driving potential (vapor pressure of water minus partial pressure of steam); and the total square feet of water surface in each of the zones, by dividing the unit condensation into the total required.

The remaining condensation will take place at continuously decreasing temperatures as the partial pressure of the steam decreases. It is convenient to divide the rest of the condenser into zones of equal temperature drop. Six zones in each of which there is a drop of 3 deg. will be suitable. From the vapor pressure at the lower temperature in each zone the partial pressure of the steam can be calculated and from this the number of mols of steam remaining at the end of each zone. The condensation in each zone will give the number of B.t.u. extracted and this, in turn, the average water temperature. From the average quantity of steam flowing in each zone, in relation to the quantity of gas, the average partial pressures of steam and gas can be determined, and hence, K. Knowing the average water temperature, the differential partial pressure can be calculated and hence the condensation per hour per unit area, and the water surface required to give the required total condensation for the zone.

Carrying through the calculations outlined above gives the results listed in Tables I and II, and from them Fig. 7 has been prepared. The total surface, on the basis of a velocity below the critical throughout the condenser, is the sum of the surfaces determined for each zone, or 345.8 sq.ft. With the terminal difference 5 deg., the overall heat transfer rate is 5,230,000/(345.8×5) = 3,030 B.t.u., which is decidedly in line with expectations. In order to design for this surface we need a circular curtain averaging 4 ft. in diameter, falling 14 ft. Both sides are effective. With a condenser 5 ft. 6 in. in diameter, the total height will then be about 16 ft. which is well in line with commercial practice.

If we had assumed turbulent flow in the air cooling section, say a velocity of 100 ft. per second or 0.235 lb. per square foot per second, K in the last four zones would have been $80(0.235^{0.8})(1.50)/(30)^{0.5}P_g$. The surface of the last four zones could then be cut to 137.7×2.36/6.89=47.7 sq.ft. Referring to the construction shown in Fig. 6*a*, in which the saturated gas is caused to pass through a short curtain of water at a high velocity, we could, perhaps, get an even better reduction in the total size of the condenser by this practice. The heat transfer at this point can be determined only by empirical means. On the other hand, a design of this character is not suitable for high overloads. When noncondensable gas, superheated steam and a large proportion of product vapors enter the condenser, the diffusion rate in the lower

Table I—Condenser Calculations by Zones of Equal Heat Transfer

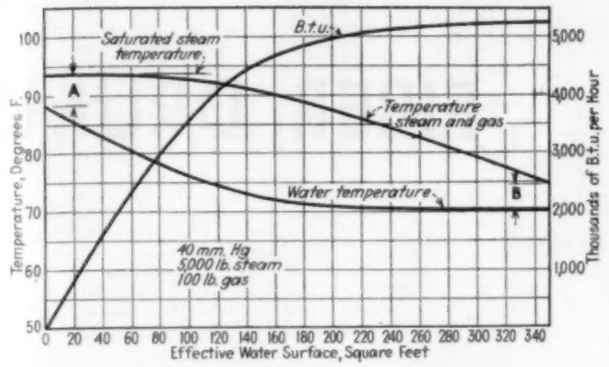
(Basis, 60 per cent of condensing)

Zone	No. 1	No. 2	No. 3
B.t.u. per hour	1,040,000	1,040,000	1,040,000
Steam condensed, lb. per hr.	1,000	1,000	1,000
Avg. steam flow, lb. per hr.	4,500	3,500	2,500
Mols steam flowing	250	194	139
Mols gas and steam	253.3	197.3	142.3
Partial pr. steam, mm.	39.6	39.3	39
Partial pr. gas, mm.	0.527	0.675	0.931
Temp. steam, deg. F.	93	93	93
Temp. water, mean, deg. F.	86.2	82.6	79
Mass transfer, K	4.47	3.5	2.52
Vapor pr. water, mm.	32	28.5	25.2
Partial pr. diff., mm.	7.6	10.8	13.8
Vapor transfer, lb. per hr. per sq.ft.	34.0	37.8	34.8
Surface required, sq.ft.	29.4	26.5	28.7

Table II—Condenser Calculations by Zones of Temperature Drop

(Basis, 40 per cent of condensing)

Zone	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9
Steam temp., deg. F.	93–90	90–87	87–84	84–81	81–78	78–75
Steam v. pr. at lower temp., mm.	36	32.8	29.8	27.0	24.6	22.1
Steam, per cent total pressure	90	82	74.5	67.5	61.5	55.2
Steam at lower temp., mols per hr.	30	15.1	9.76	6.90	5.33	4.10
Steam, lb. per hr.	2,000–540	540–272	272–176	176–124	124–95.8	95.8–73.9
Condensation, lb. per hr.	1,460	268	96	52	28.2	21.9
B.t.u. per hr.	1,590,000	295,000	106,000	57,300	31,000	24,000
Water temp., deg. F.	77.2	71.7	70.7	70.3	70.1	70.1–70
Steam flow, mean, lb. per hr.	1,270	406	224	150	110	85
Steam flow, mean, mols	70.5	22.6	12.4	8.33	6.10	4.72
Total mols	73.83	25.93	15.73	11.66	9.43	8.05
Partial pressure gas, mean	1.8	5.13	8.45	11.4	14.1	16.5
Mass transfer, K	1.31	0.460	0.279	0.207	0.167	0.143
Vapor pressure water, mm.	21.7	20	19	18.8	18.8	18.8
Partial pressure diff., mm.	14.3	12.8	10.8	8.2	5.8	3.3
Vapor transfer, lb. per hr. per sq.ft.	18.7	5.9	3.1	1.7	0.97	0.472
Surface required, sq.ft.	78.0	45.3	31.5	30.6	29.1	46.5



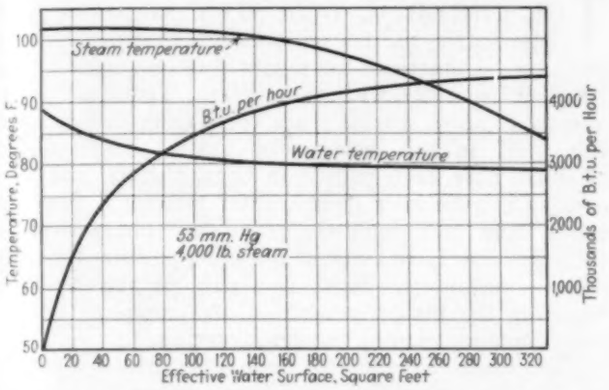


Fig. 7—Performance of barometric condenser based on accompanying calculations

Fig. 8—Performance of barometric condenser based on actual operating data

section is greatly reduced. As a result, large volumes of steam try to pass through the small openings with a very high pressure drop.

The basis of design given above is perhaps pure conjecture. At 350 sq.ft. the condensing rate is 14 lb. per hour per square foot. The volume is 380 cu.ft. and the condensation 13.2 lb. of steam per cubic foot. As an indication of the performance of various commercial designs, Table III lists data submitted in connection with bids covering one definite set of performance requirements. The method of water distribution has a considerable effect on the physical size of the condenser. The effect on the price is less, however, since spray nozzles are inherently expensive.

Fig. 8 shows the performance of an actual commercial installation tested by the writer. The abscissas of the chart have been multiplied by a factor to prevent identification of the actual data source. Comparing this with Fig. 7, derived from the theoretical design, it is clear that there is normally heavy condensation of steam in the bottom of the condenser. Comparison of temperature gradients indicates this clearly. In examining the performance of the same commercial unit when light oil was entering the condenser with the steam, practically no condensation was found to occur in the lower section. In the air cooler section the steam velocity was so great that 25 mm. pressure drop occurred, yet when handling a normal quantity of gas, this condenser operated with no pressure drop.

Correct application of the principles outlined above will often solve the baffling difficulties which sometimes are encountered in operating vacuum equipment.

Table III—Performance of Barometric Condensers

(Bids submitted for handling 16 to 1 steam to dry gas ratio at 33 mm. abs. with 68 deg. F. injection water)

Type of Condenser	Pounds Steam Per Hour Per Cubic Foot	Temperature Differences, Deg. F. Approach	Terminal
Fig. 6a	18.2	5	9
Fig. 6b	13.8	5	7
Fig. 6b	12.8	..	..
Fig. 6c	46.7	3	4
Multiple nozzle spray	34.6	5	8

The most usual cause of trouble is leaks. They should not, and need not be tolerated. They overload the ejectors to the breaking point, causing pressure drop in the barometric condenser. Another difficulty often encountered is low steam pressure on the ejectors. A common habit of many operators is to use too much water on an ejector barometric type intercondenser, thus flooding the secondary stage. About 15-20 deg. F. temperature rise should be maintained on this water.

Finally, rust or corrosion in the steam strainers and nozzles, or corrosion of the diffuser, will cause ejectors gradually to lose their efficiency. When corrosive vapors are handled special alloys should be used.

In order to locate trouble, it is advisable to proceed as follows:

1. Check the initial steam pressure to ejectors.
2. Check the air temperature to the ejectors if possible.
3. Check the inlet and outlet circulating water temperatures to the barometric and the ejector intercondenser.
4. Examine and clean the ejector steam strainers.
5. Shut down and test for leaks.
6. Disassemble and inspect the ejector nozzles and throats.

When the proper steam pressure is maintained at the ejector nozzles, when the ejectors are in proper working order and the system free from air leaks, failure to maintain vacuum may then be attributed to insufficient size of barometric or ejectors, or both. When the barometric is undersized, a high air temperature to the ejectors may be observed.

On the other hand, a common complaint is little improvement in vacuum when increased circulating water or lower temperature circulating water is used. The ejectors control the vacuum. Referring to Fig. 4, it will be seen that there is a "dead-shut off" point below which the ejectors cannot maintain the absolute pressure. Hence, in a system designed to run at 45 mm., for example, circulating water double the normal quantity might not reduce the absolute pressure to below 40 mm. This fact becomes more pronounced when the ejectors fail to function properly. Even freezing water might fail to give 25 mm. absolute pressure, although the possible absolute pressure is below 10 mm.

In a system such as is shown in Fig. 1 the product, which is supposed to be condensed in the surface condenser, is often carried into the barometric. This is often blamed on mechanical entrainment. Actually it is usually caused by saturation of the process steam with the product of the operation, since equilibrium condensation does not occur in a tubular condenser. If the product temperature is brought low enough to eliminate carry-over to the barometric, there will probably be some condensation of steam with the product. On the other hand, if the product temperature is raised sufficiently to eliminate water, the steam will become hot enough to take up considerable of the product in saturation. Whether to allow water to condense in the product, or to permit some degree of carry-over will depend on individual circumstances.

Vacuum problems in chemical engineering industries are so widely different from those of the steam power plant that the power condenser is not suitable for this work. So few manufacturers of this equipment have had suitable experience that it behooves the designer, the operator and the purchaser to think for themselves when it comes to equipment of this type.

FIBER DRUMS

TOP—Resiliency of all-fiber drum absorbs shocks and returns to original shape. CENTER—All-fiber drum with bottom and head attached with gummed fabric tape. BOTTOM—Fiber seal, solid wood head and steel rim, fastened with nails or clips

THE CHEMICAL INDUSTRY has reason to be conservative in the selection of containers for its products. Experience has taught it to look upon all new types of packages with skepticism. Therefore it frequently requires several years for a newcomer to establish itself in this field. For years, powdered bulk products have been packed in bags, barrels, and metal drums, but the fiber drums, after making a few false starts have very definitely established themselves. In fact, they now have assumed a leading position for transporting certain powdered products, particularly those requiring the utmost protection and complete freedom from contamination by foreign materials.

Fiber drums have proved their superiority for particular shipping problems and are now a common sight upon all the shipping highways of the world. Their light tare weight, their extreme strength, and their cleanliness are truly builders of good will. Since duties in some foreign countries are levied on gross weight, the light tare of the fiber drums make them highly desirable for this service. The tare also is an important consideration in air transportation rates.

In the past, paperboard was not commonly considered to have great strength or durability. We will readily agree that containers fabricated from paperboard make effective packages for small amounts of coffee, sugar, flour, and the like, but it is extremely difficult for us to visualize a paper package which will carry successfully up to 400 lb. It was with great foresight that the makers of fiber drums created a product sturdy enough to compete with metal drums and other carriers constructed of materials with high tensile strengths.

The basic reason that the fiber drums can stand excessive abuse is their flexibility. They give or distort with heavy shocks and then slowly return to their original contour. The unyielding properties of wood and steel containers often cause distortion and ultimate failure under stress, whereas these forces may be overcome by the pliability of the fiber drums. As a convincing example, consider the mailing tube. It passes through many hands, encountering all conditions and seldom arrives at its destination in other than first class condition.

Until recently, jute liner board was the only material used for fabricating fiber drums as well as the commonly known corrugated and solid fiber shipping containers. This board consists of a small part of new kraft pulp mixed with a major portion of various grades of waste papers which are collected by rag and waste paper dealers throughout the larger cities.

Shortly after the introduction of the manufacture of kraft pulp and paper in the South it was found that these

FOR SHIPPING CHEMICALS

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mills had a surplus production capacity which caused them to seek new outlets. This led to the introduction of the kraft liner board into the container field and as this kraft liner is of exceptional strength and high quality it proved to be a great benefit to container manufacturers.

For many purposes and particularly for fiber drums, the kraft liner board manufactured on the fourdrinier type of paper machines has proved particularly well adapted. This paper is formed by flowing the kraft pulp of about 99 per cent in water upon a vibrating screen, sufficient to make the thickness of paper desired. The water passes off and the pulp fibers are thoroughly matted. The remaining water is evaporated as the wet sheet of pulp is passed through a series of presses and around heated rolls serving as dryers. The paper is then passed through calenders which apply the smooth finish. Close control of the strength and quality of the paper is maintained through constant testing. It should be recognized that 100 per cent kraft liner board supplies exceptional strength not easily obtained in the adulterated or composite jute liner boards.

Fiber drums are in demand for packing those more valuable powdered products which require the maximum protection from contamination and where the dispensing advantages of the full open head are recognized. In addition, materials which must be protected from moisture can be safely packed in some types of fiber drums which are specially constructed to resist the transmission of water vapor. Included in these substances are molding powders, pharmaceutical chemicals, rubber accelerators, cleaning powders, poisonous insecticides, C.P. chemicals, and many others. The fiber drums have firmly entrenched themselves in the food industry and they are now used for packing ground coffee, cocoa, spice, powdered eggs, powdered milk, sugar, baking powder, salted nuts, and the like. Meat packers have been using these drums for several years for packing certain grades of meats.

There are several types of fiber drums on the market, most of which have proved to be somewhat better than the ordinary slack barrel. Some drums are made of a combination of fiber board and rigid materials, such as wood or steel. The difference in flexibilities of the materials tend to separate them under severe shocks. The heads are constructed of rigid materials and the failure usually occurs at the chimes where the flexible fiber shell is joined to the heads.

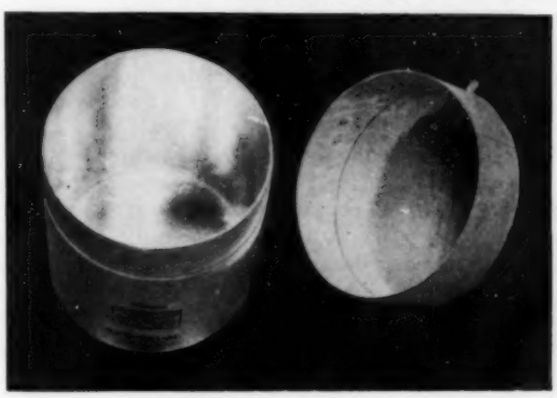
The all-fiber drum is outstanding and compares favorably in strength and ruggedness with those light gage metal drums used for single shipments. These all-fiber drums are more apt to be punctured than the metal packages if they are struck by sharp objects, such as the lips of hand trucks. On the other hand, they better withstand dropping and rough handling. Drop tests will show that the metal drums distort and finally tear, usually at the head seams, while the fiber containers, through their flexibility return to their original shape after each drop.

The cylindrical shells of most types of fiber drums consist of several plies of paper board wound on a mandrel and bound together with silicate of soda or other adhesive. The paper varies from ordinary chip board to the best fourdrinier kraft liner board. The most important features of the containers from the standpoint of strength are the means employed to attach the bottom of the drum and the design of the cover. The more important methods in use are as follows:

1. One end of the cylindrical shell is flanged inward and circular fiber disks are attached on the inside of the bent wall of the shell by stitching with flat wire about an inch from the outer periphery. Other disks are then glued over the stitches to completely cover the metal stitching. Another shell is then forced down inside the outer shell and against the bottom disk. The bottom of the drum is dipped in paraffin for protection against water and a metal hoop is attached to provide easy rolling and prevent fraying of the bottom. This drum is closed by means of a telescopic cover which is formed as described for the bottom. The cover is forced down over a sealing disk which covers the mouth of the drum, and it is held in place by sealing two plies of 60-lb. kraft gummed tape 3 in. wide over the joint of the cover and bottom shell. The outer bottom shell does not reach to the mouth of the drum, so the cover can be taped on two surfaces with a flush joint.

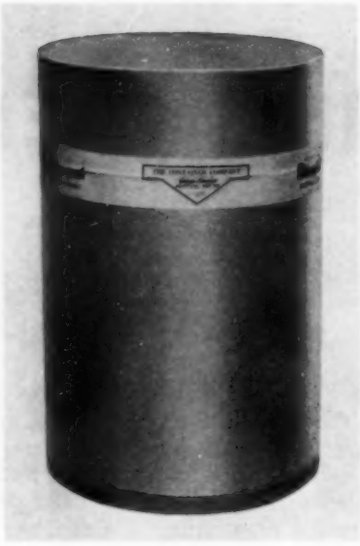
2. Ends are formed of circular wooden disks about $\frac{13}{16}$ in. thick which are flanged outward so they will set

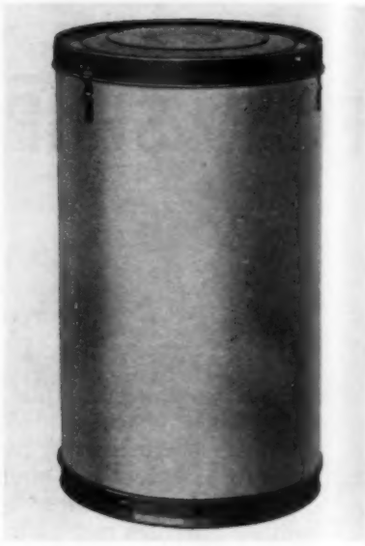
All-fiber drum with aluminum foil lining



inside the cylinder and extend over the top of the shell. These wooden disks are forced into the drum over sealing disks which cover the openings. Steel hoops which have been hinged on one side are then placed over the tops and bottoms of the drums and nails are driven horizontally through holes in the hoop, through the fiber side walls and into the wooden heads.

3. Another means of fastening the bottom is to turn a steel hoop over the bottom of the cylindrical wall and insert tight-fitting fiber disks into the drum. The beading on the inside of the hoop holds the disks in place. The disks are prevented from moving towards the top or mouth of the drum by several plies of the inner wall of the cylinder which do not extend to the bottom. The top has a steel hoop attached to the outside wall to allow easy attachment and removal of cover. The cover consists of a circular fiber disk which is attached to a metal rolling hoop by swedging two channels on the hoops, one on each side of the disk. The resulting slip cover is attached by imbedding several metal sealing clips in the fiber of the side walls and cover by the use of a special tool to apply these clips.





Left—Fiberpak all-fiber drum. Right—The Stapak fiber drum with metal bottom and metal cover

4. Still another type has metal bottoms and covers. The metal bottom is attached by wire stitches through the side of the bottom which extends over the fiber side wall and through the fiber cylinder. Pressure is applied to the metal at the chime to force a tight grip of the fiber side wall. The slip cover is all-metal and it is held in place by the means of metal sealing lugs which are attached to the side walls of the drums. These lugs pass through slots in the rim of the metal cover and are bent down against the side wall of the drum. Another manufacturer fastens the cover by punching split rivets through the cover and the side wall. There are several minor variations of this type, mostly as to methods used in securing the cylindrical body of the drum to the metal ends.

5. Another type has fiber bottoms and covers which are shaped by drawing moist fiber disks under pressure. They are fastened to the shell by the use of gummed bias woven cambric tape.

The three most important types of paper board used in winding shells vary in thickness from 0.014 in. to 0.02 in. There is jute boxboard liner which consists of a mixture of approximately 70 per cent waste paper and 30 per cent kraft pulp to provide strength. Ordinary chipboard, consisting of all waste papers is also used. The strongest paper board is made from all kraft pulp. Most fiber drums are made from one or more combinations of these three types of board. The strongest side walls of course are those which contain the most kraft board.

Most fiber drums are water resistant to the extent that they can withstand ordinary exposure to the elements. Kraft liner board is inherently water resistant and the silicate of soda adhesive is also water proof. Continual exposure to water may cause leakage and will ultimately tend to soften the side and ends of the container.

The drums are provided with resistance to the transmission of water vapor by the inclusion of certain types of moisture resisting materials in the shell, the head and the bottom or by spraying or dipping the completed drum in paraffin or wax. Spray coating of the inside of the drum with moisture resisting compounds is a method that has not been fully developed although some coating materials have been found which will efficiently seal the drum.

Asphalt laminated board is the most commonly used for moisture protection but it is a difficult problem to effectively seal the joint between the bottom and the cylindrical side walls. It is also difficult to make a tight longitudinal joint of the moisture resisting ply in the wound tube. Within the last year aluminum foil laminated to paper has been used for interior lining and this material has given exceptionally fine results.

Theoretically, the best method of moisture protection is to use a homogeneous coating on the inside of the drum. This method avoids the disadvantage of either lapping or butting the joints of the moisture resisting plies. It also overcomes the difficulties of cementing these materials together. The chief difficulty in obtaining an effective spray coating on the inside of the drum is that it is difficult to find one which is sufficiently flexible to withstand cracking when the drum is distorted and one which will cover the end and side joints of the board. Chlorinated and dispersed rubber compounds have been found to overcome this but they are expensive.

The Consolidated Freight Classification Committee has compiled specifications with which all fiber drums must comply for rail shipment and the drum manufacturer must affix to each drum a certificate stating that the container meets the requirements of the Committee. These specifications are covered in Rule 41, Section 11, which provides detailed specifications for fiber drums to carry dry products and a separate set of specifications for

drums to hold semi-liquids and articles that are not dry.

The use of fiber drums are also authorized by the I. C. C. for shipment of inflammable solids and class B poisonous powdered materials other than those compounds for which special packing is required. These drums are also authorized for shipping some of the special poisons such as arsenic, arsenate of lead and mixtures containing this poison and others. The container specification is number 21A and it will be found in supplement No. 9 of the I.C.C. Regulations for the Transportation of Explosives and Other Dangerous Articles. There are two types of fiber drums which will meet these specifications—one is the slip cover all-fiber type construction which was previously described in drum construction No. 1 and the other is the drums having flanged wood heads described in No. 2.

Possibly the most exacting service in which fiber drums are used is the transportation of urea molding powders. Powders of this type include the most delicate colors and they must be kept entirely free from the slightest contamination or a large percentage of rejections of molded pieces caused by dirt and other foreign materials will result. It is unfortunate that much of this contamination cannot be detected before the pieces are molded. Even the slight amount of fiber that may fray from the cover and the mouth of the drum has been found to cause trouble and has had to be eliminated.

Damage from contamination is a problem to be guarded against. Makers carefully protect their products during manufacture but at times fail to consider this in the choice of containers. The nail or staple fastenings used in wooden containers often cause the introduction of wood splinters and sometimes even the nail or staples find their way into the contents. Rust is a possible source of contamination from metal containers. Some of these are lined with lacquer coatings to prevent oxidation. These coatings are effective as long as the metal is not bent to the extent that the lining is cracked or until abuse or blows distort the container at the seams and thereby expose uncoated metal.

Containers protected by paint which are stored over long periods under unfavorable storage conditions must often be repainted before they can be shipped. This is of extreme importance for materials which have a seasonal use such as insecticides. The cost of returning containers from storage warehouse and repacking or repainting is an important item and adds a large percentage to the original price of the packages.

Often the best grades of fiber drums are reused, in fact there are some shippers who have used these drums for interplant shipments from 5 to 15 trips before they have to be discarded. Another outstanding feature of these containers is their value to the emptier. Although there is little or no second hand market for them they can be used for shipping their finished products. They are in demand for waste cans, roving cans and other industrial uses. In the home they make handy containers for waste paper. This is particularly appreciated in cases where heavy sheet iron cans must be carried up the cellar stairs. Some housewives pack their winter woolens in them each spring knowing that if there are no moths present in the garments when they are packed none can enter as long as the cover is securely fastened. In fact one company ships a cleaning compound in these drums and includes a sample of their moth repellent in each drum with instructions for the preparation and storage of woolens. As a last resort they can be disposed of inexpensively by burning when they are unfit for further use.

There is a real advantage of a decrease in tare weight for the fiber drum. The following table may be used for approximate calculations of this difference:

41 gal. all-fiber drum	tare weight 17.5 lb.
41 gal. 24-gage steel drum	tare weight 23 lb.
Slack barrel of 41 gal. capacity	tare weight 25 lb.

Who knows what the future has in store for the fiber drums? Will the years add new developments to this excellent package to make it even more superior? It was men with vision who conceived them and is it logical to expect them and their successors to continue this good work? With the incentive of the increasing emphasis that is being placed on packaging in so many branches of industry our prophesy is that future changes will raise the fiber drums to even greater heights.

Why Pulsations Occur in Chain Conveyors

By CHESMAN A. LEE
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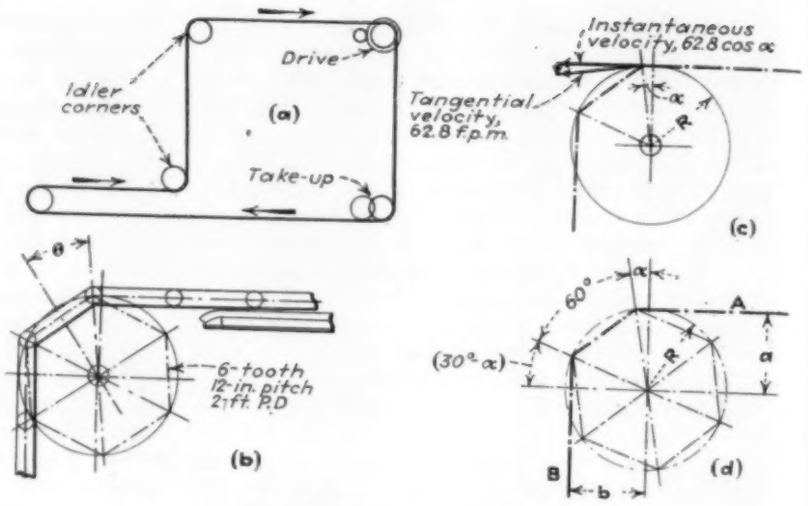
CONVEYORS using chains to transmit the power, such as pivoted bucket and vee conveyors and tray elevator-conveyors, generally exhibit intermittency of motion which is more or less objectionable and in extreme cases may even cause mechanical failure. An interesting example which came under the observation of the writer was that of a pivoted bucket conveyor used for chilling a certain chemical and solidifying it into cakes. As the material contracted on crystallizing, the cakes were expected to shrink and slide out readily when the buckets were tipped. Actually, however, the chemical crystallized as a hollow cake filled with liquid. This cake shrank away from the bucket as expected but a slight pulsation in the conveyor caused the remaining liquid to slop over and crystallize between the cake and the bucket. Only through the installation of a rapper was it possible to loosen the cakes.

In the accompanying drawing, the sketch at (*a*) illustrates a typical chain conveyor system. It should be mentioned that in a "trouble job" there is not the same amount of pulsation throughout the system. Such an installation always has two or three corners besides the take-up. In sketch (*a*), passing backward from the drive, the first section will move at an almost steady rate, although the drive may give audible evidence of periodicity. The second section may have a visible pulsation, the pulsation becoming increasingly evident as each corner is passed in sequence.

It will be shown that each corner is a potential source

of pulsation and that there are methods for eliminating the difficulty. It is entirely practical to use alternate pulsations to cancel the one preceding and even possible, at slightly higher expense, to avoid introducing such pulsations entirely.

To a certain extent pulsation (velocity variations) is inherent in a chain conveyor because the chain fits the driving sprocket in a pitch polygon rather than in a circle. This will be evident from sketch (*c*), which shows that the velocity of the drive point has two components 90 deg. apart which vary periodically and that only the horizontal component is effective in advancing the chain. The velocity variation will depend entirely upon the number of teeth in the driver, becoming greater the smaller the number of teeth. The pulsation which otherwise would be introduced at the driver can be compensated through the use of one of the equalizing drives that are available, but pulsation from the drive alone is ordinarily unimportant. It is those pulsations independently introduced at the idler corners which are likely to give the greatest difficulty. Corner sprockets do not merely magnify a pulsation already in the chain, but actually generate more serious ones themselves, unless properly designed. The writer has seen a heavily loaded conveyor where a single compounding caused a rhythmic groaning of the drive, finally resulting in failure of the motor shaft.



Analysis of chain conveyor system

Sketch (*b*) shows a six-tooth drive sprocket of 12-in. pitch and 2 ft. pitch diameter which at 10 r.p.m. will advance the chain by 60 links in one minute, or at an average rate of 60 ft. per minute. It will be clear that during a rotation of 60 deg. the chain will advance one link and that the horizontal component of the drive point velocity will pass from a maximum through a minimum to a maximum, during such rotation. The instantaneous velocity, as in sketch (*c*), will equal the maximum velocity times cosine α or in this case, $2 \pi R \times$ (r.p.m.) $\times \cos \alpha = 62.8 \cos \alpha$. Hence during 60 deg. rotation the maximum velocity reached will be 62.8 ft. per minute, the minimum, 54.5 (when $\alpha = 30$ deg.) and the average 60 ft. per minute. By the same reasoning, for any sprocket with pitch radius R, n teeth and center angle between teeth 2θ, the instantaneous speed may readily be calculated as a function of the degree of rotation, α. For the maximum and minimum velocities where $\alpha = 0$ and θ, chain speeds are (average speed) $\times \pi \csc \theta/n$ and (average speed) $\times \pi \cos \theta/n$, respectively.

So far nothing has been said about the relative speeds of the two strands of chain approaching and leaving the sprocket. It has been assumed that the rotational speed of the sprocket is constant, as in the case of a driver. But the idlers, being driven themselves by chain which is pulsating, rotate non-uniformly. In considering the relative speeds of the two strands at an idler, therefore, it is desirable to eliminate the rotational speed. For the sprocket shown, strand B has the speed $2 \pi R \times$ (r.p.m.) $\times \cos (30 - \alpha)$ while that of strand A is $2 \pi R \times$ (r.p.m.) $\times \cos \alpha$. Their ratio then is $b/a = \cos (30 - \alpha)/\cos \alpha = 0.886 + 0.5 \tan \alpha$. It will be evident from a study of the drawings, however, that had the corner angle been 60 deg., then b would have equalled a and the simultaneous speed of the two strands would have been the same. Similarly, with an eight-tooth sprocket at a 90-deg. corner, no pulsation can be introduced. A seven-tooth idler at a 90-deg. corner would produce pulsations with unsymmetrical periods, but such an idler need not be used for, with proper design, the cheaper six-tooth idlers can be used.

It is evident, then, that phase differences between the several driving points in a closed conveyor loop make it possible for one section of conveyor to be traveling momentarily at a distinctly different speed from a section just around the corner. It is clear that the two speeds have to average up but it actually works out that a six-tooth idler at a 90-deg. corner will introduce such a pulsation that the section of chain approaching the sprocket will alternately be slowed down 13.4 per cent and speeded up 15.5 per cent, with an overall variation of 28.9 per cent.

From this analysis, it is possible to state two general rules of design:

1. Conveyors should be laid out so that each run of chain contains a whole number of chain pitches between tangent points. When this rule is followed, sprockets will rotate in phase and pulsations cannot add up, although there may be pulsations in alternate sections caused by the idlers. These pulsations will all have the same value which, however, will be appreciably less than expected because they act to overcorrect that introduced by the drive.

2. When possible, sprockets should be so chosen that the chain wrap (usually 90 deg.) is exactly divisible by the pitch. When this rule is followed, it will absolutely eliminate idler sprockets at sources of pulsation and will permit neglect of the first rule.

The average installation will be satisfactory if the first rule only is followed, but both rules must not be neglected at the same time in any case where either corner sprockets or wheels (which give the same effect) are employed. Proper attention to these rules will pay dividends both in the satisfaction that comes from efficient operation and in actual reduction in maintenance.

Columbus and Ohio State Hosts to Ceramic Society

EDITORIAL STAFF

DURING the week of March 29, Columbus and Ohio State University played hosts to the largest group of ceramists to assemble in recent years. The event was the 38th annual meeting of the American Ceramic Society. The annual meeting of the Association of Ceramic Educators was held at the same time as was also the biennial convocation of Keramos, professional ceramic engineering fraternity. About 1,000 were in attendance. The program included 150 papers, social events and two days of plant visits.

The new officers of the Society for the year 1936 are as follows: President, Francis C. Flint, Hazel-Atlas Glass Co., Washington, Pa.; vice-president, R. B. Sosman, U. S. Steel Corp., Kearny, N. J.; treasurer, H. B. Henderson, New Brighton, Pa., and general secretary, Ross C. Purdy, Columbus, Ohio. A. S. Watts, Ohio State University, Columbus, was elected Dean of the Fellows. The new members of the Board of Trustees are George H. Brown, Rutgers University, New Brunswick, N. J.; J. L. Carruthers, Ohio State University, Columbus, Ohio, and J. L. Child, Hancock Brick & Tile Co., Findlay, Ohio.

This year the Edward Orton, Jr., Memorial Lecture was given by W. J. McCaughey, Ohio State University. His subject, "Contribution of Mineralogy to Ceramic Technology and Ceramic Research," dealt principally with the revelations of the X-ray concerning the atomic structure of ceramic products.

A continuation of the discussion on the firing of ceramic ware which aroused so much interest at last year's general session took up Monday afternoon. W. E. Rice, of the Bureau of Mines, discussed combustion data; H. C. Weller, of the Surface Combustion Co., took up the effect of furnace atmosphere on ceramic ware; J. L. Carruthers of Ohio State University, discussed the importance of the control of cooling. L. S. Briggs of Trenton, N. J., and W. D. Richardson of Columbus, Ohio, had interesting papers on car tunnel kilns and J. T. Littleton of the Corning Glass Co., Corning, N. Y., on the effect of heat on glass.

The materials and equipment division presented a valuable program which included a description of the mining and processing of two North Carolina minerals which have come into prominence during recent years. F. L. Mattson, Burnsville, N. C., dealt with cyanite and B. C. Burgess of Spruce Pine, N. C., with pyrophillite. The remaining papers covered in considerable detail the subject of determining the sizes of fine particles. P. S. Roller, Bureau of Mines; Louise B. Harrop, Rutgers University, and C. R. Amberg, New York State College of Ceramics, discussed this subject.

Much of the enamel division's time was given to the discussion of the adherence of glass to metal. C. R. Amberg, H. D. Prior and J. C. Richmond, of the New York State College of Ceramics, explained a new method of eliminating the ground coat by plating the steel with molybdenum. A number of papers dealt with measurements, specifications and tests of enamels and steel and others with details of shop practice.

Some of the most interesting papers on the refractories division program were on the subject of the production of dense aggregates. H. E. White, Lava Crucible Co., Pittsburgh, found that the densest packing arrangement is obtained with spherical-shaped grains. E. J. Bognar, Corundite Refractories, Inc., Massillon, Ohio, described recent advances in the manufacture of insulating refractories. It has been found that this new product must be made to suit the furnace in which it is used in order to obtain best results.

Use of X-rays in the investigation of refractory problems has received considerable attention and from the discussions it was evident that X-ray equipment in refractories laboratories will become increasingly important in the future.

G. Slayter, Owens-Illinois Glass Co., Toledo, described the properties of the new glass yarns before the glass division. He described the production of fibers having diameters of 0.0007 to 0.00005 in. with remarkable tensile strengths, some running as high as 1,500,000 lb. per square inch. These new fibers offer most interesting possibilities in the production of glass textiles. A display of new products made from glass yarns attracted a great deal of attention.

As in the refractories division, the use of the X-ray in the study of composition and properties came in for considerable discussion. B. E. Warren, Massachusetts Institute of Technology, discussed the Fourier analysis of X-ray patterns in studying the atomic structure of vitreous SiO_2 and B_2O_3.

The structural clay products and terra cotta divisions again combined their programs. The main topic was the effect of deairing on the properties of finished products. T. W. Garve, Columbus, presented data gathered in an investigation of 75 plants using deairing machines. Definite improvement in products has resulted in almost every case. J. W. Isenhour of G. W. Isenhour & Sons, Salisbury, N. C., described in detail the experimental work necessary in changing from the old to the new method of extrusion. J. Edgar Rankin, of the Pine Hall Brick & Pipe Co., Pine Hall, N. C., described the equipment designed by his company to apply evacuation to the sewer pipe press.

In the white wares division, R. F. Geller and A. S. Creamer, of the Bureau of Standards, gave the results of an investigation of the effect of talc additions to white bodies. They found this mineral greatly improved bodies of the wall tile type so far as resistance to rehydration was concerned. Robert Twells, Electric Auto-Lite Co., Toledo, described some of the possibilities of spray-drying in preparing ceramic materials, suggesting it as a cheap, quick method of drying certain ceramic materials.

Several interesting papers on the subject of the effects on white bodies of clays, feldspars, talcs, bentonite and other minerals in various amounts and of differing compositions were presented by E. Schramm and F. P. Hall, Syracuse, N. Y.; L. W. Kane, New Brunswick, N. J.; M. A. White, Jr., and A. L. Johnson, New Brunswick, N. J.; W. W. Meyer and T. A. Klinefelter, Washington, D. C.; J. W. Whittemore, Blacksburg, N. J.; and C. J. Koenig, Columbus.

Class I Pressure Vessel Built By Gas Welding

CONSTRUCTION of what is believed to have been the first pressure vessel fabricated by gas welding to meet A.S.M.E. Code Class I requirements was described at the meeting of the International Acetylene Association held Nov. 12-15, 1935. An abridgment of the paper, which was presented by G. W. Plinke, director of research of the Henry Vogt Machine Co., of Louisville, is given below.

With the adoption of the A.S.M.E. Code for Unfired Pressure Vessels and Power Boilers in 1931, certain standards were established for the physical properties of weld metal in steel plate construction. In Class I the highest weld qualities and most stringent requirements of construction were specified, including stress-relieving of the entire vessel and X-ray examination. The highest operating fiber stress was permitted for this class of construction and no limitations were placed on pressures, temperatures or service conditions. The welding of power boilers was limited to this class of construction.

During the early attempts to perfect the applications of welding to pressure vessel construction to meet Class I requirements, oxyacetylene welding was somewhat neglected and its possibilities overlooked. The oxyacetylene process was confined in application to construction equivalent to Class II requirements and no particular attention was paid to developing a procedure to accomplish the physical properties specified for Class I.

After several years' experience in fabricating welded pressure vessels and power boilers in accordance with Class I construction, using the coated electrode electric arc process with the required special technique of control, Mr. Plinke's company began investigating the possibilities of oxyacetylene welding. Numerous tests were made to determine the physical properties of the weld metal using regular gas welding procedure, and then certain modified methods. Prior to this investigation a so-called neutral flame had always been used. However, it was found that a reducing or slightly excess acetylene flame materially improved the ductility of the weld metal and such defects as porosity or oxide inclusions were practically eliminated. The proper type of flame in gas welding causes a protecting gas envelope around the molten metal and prevents the formation of nitrides and oxides in the weld metal owing to infiltration of contaminating gases, much the same as does the coating on the electrode used in electric arc welding.

It was found that by the use of proper procedure, weld metal would be produced which was of high quality and generously met all the requirements of the A.S.M.E. Code for Class I welding. An encouraging fact was the consistency of results as shown by repeated tests. The company then decided to qualify a number of welding operators.

Shortly after qualifying the welders the company received an order to fabricate a Class I gas-welded vessel, 5 ft. 6 in. in diameter and 13 ft. long, having a wall thickness of 1 in. and constructed for a working pressure of 250 lb. per square inch. The plates and heads were prepared with a double vee type groove and the weld metal laid down in four layers with cleaning and inspection of each layer. On completion of the longitudinal seam it was X-rayed and two small defects of no consequence, which were nevertheless repaired, were found. The heads of the vessel were then welded to the shell, using the same general procedure as in welding the longitudinal seam. Little or no distortion occurred. Both seams were then X-rayed, disclosing a very few defects which were only of a minor nature. These were chipped out, repaired and again X-rayed. Finally, the manhead and nozzles were fitted and welded to the vessel, the vessel was stress-relieved at 1,200 deg. F. in accordance with the A.S.M.E. Code requirements and then given the prescribed hydrostatic test.

Since this was the first gas-welded vessel constructed to meet Class I requirements of the A.S.M.E. Unfired Pressure Vessel Code, a most rigid system of inspection and control of all the details of construction, as well as the inspection of the exographs of the welded seams, was maintained at all times. Commercial standards of quality for Class I construction in accordance with the A.S.M.E. Code would not have required the removal and rewelding of any of the spots located. The repairs which were made were only of very minor extent and were made only to satisfy the company's own rigid requirements.

Cost Can Be Reduced

The cost of fabricating this vessel was considerably in excess of the cost of an equivalent vessel fabricated by electric welding, but as more gas-welded vessels are fabricated to meet Class I requirements, the cost will naturally be reduced. Doubtless, multi-flame torches or semi-automatic equipment with gravity fed welding rods will eventually be applied to heavy plate work and materially reduce the cost of oxyacetylene welding. In fact, full mechanization of the application of the oxyacetylene process also seems to have some very definite possibilities.

There are two other factors which seem to favor further developments of oxyacetylene welding for Class I construction, now that it has been well demonstrated that the physical requirements may be readily complied with. In the gas welding of Class I pressure vessels welds that are practically flawless should be capable of production and repairing of welds should be largely eliminated. Furthermore, because of the lower temperature gradients established between the base metal and weld metal in gas welding, residual stresses are not as highly concentrated as in electric welding. Although Class I vessels are stress-relieved to relieve such stress concentration, this factor may at times require special procedure for electric weld construction which would not be required were gas welding employed.

In closing, Mr. Plinke suggested that in the near future an automatic welding machine may be developed to combine and make use of the good qualities found in both the gas and electric processes. With a combination of these two processes, it is quite possible that an automatic machine can be built to use a coil of bare wire electrode, while the necessary atmosphere will be secured through the application of suitable gases. When such a machine is perfected it is anticipated that welding costs will be greatly reduced and an important forward step made in the art of uniting metals for industrial purposes.

Chemical Engineer's BOOKSHELF

American Lunge At Long Last

SULPHURIC ACID MANUFACTURE. By *Andrew M. Fairlie.* Published by Reinhold Publishing Co., New York. 669 pages. Price, $9.75.

Reviewed by *Theodore R. Olive*

UNTIL 1936 no first class book had been written by an American engineer to describe American practice in the making of sulphuric acid. It is true that we have had a fairly complete, if scattered, literature in transactions and the periodical press, that there have been two books of minor consequence and the famous Wells and Fogg pamphlet of the Bureau of Mines (1920). But aside from these we have had only the books of George Lunge, and later, the Lunge-Cummins revisions. Incomparable as these latter were, they represented European practice, where practice was concerned. The country producing most of the world's sulphuric acid had perforce to get along as best it could with what it could find.

Now, thanks to Mr. Fairlie and the editors of the A.C.S. Monograph series, such a first class American book is at hand. Without attempting to be exhaustive, without trying to displace Lunge so far as ultimate theory is concerned, the new monograph fills a gap in the literature which has long been felt by students, producers and consumers of sulphuric acid alike. If the book is not exhaustive and exhausting, neither is it sketchy nor elementary. In the eyes of this reviewer, who feels that to a degree he grew up with an edition of Lunge, Mr. Fairlie has turned out a work which for 1936 is more practical and certainly far more readable than that of his celebrated predecessor. For Mr. Fairlie has an easy-flowing, pleasant style, neither too heavy nor too light. He refuses to become bogged down under the weight of the load. Yet always he has the practicalities in mind. With his extremely broad background in the industry, he never loses sight of the needs of the designer, the builder and the operator of sulphuric acid plants.

To those who have long known the author as an engineer of sound reputation and wide experience in the chamber plant field, the excellence of those chapters dealing with nitration processes will come as no surprise. But—perhaps we should not say—strange to say, the more than half the book dealing with the contact processes appears to have been written with at least equal authority. The clue to this situation lies, we believe, in a happy combination of circumstances: the author's ability to observe accurately, his wide investigation outside the sphere of his own primary activity, and the excellence of the assistance he has received from such contact authorities as F. C. Zeisberg, T. R. Harney and S. F. Spangler.

Since 1925, or at least until the middle years of the depression, sulphuric acid practice has made rapid progress in the United States. And this practice, it is to be emphasized, has been tending largely away from the European methods which necessarily were imitated in the earlier days of the industry. This fact, alone, would justify the preparation of a new book, if any justification were needed. To find many references dated in the period from 1933 to 1935 is in itself proof of the timeliness of Mr. Fairlie's contribution. No process that had been used or even discussed in the United States up to the end of 1935 but has been taken into account. The author is to be complimented then not only on the authority and relative completeness of his efforts, but as well for the rapidity of his reporting. This is not a book which was outmoded before publication. It may safely be considered a standard work for at least a decade to come.

Electrochemical Engineering

PRINCIPLES AND APPLICATIONS OF ELECTROCHEMISTRY. Vol. I, 3rd edition—Principles. By *H. Jermain Creighton.* Vol. II. 1st edition—Applications. By *Walter A. Koehler.* Published by John Wiley & Son, Inc. New York. Vol. I. 476 pp. and Index. Price, $4. Vol. II. 527 pp. and Index. Price, $5.

Reviewed by *James A. Lee*

SINCE 1924 many students of electrochemistry have become acquainted with the first of these volumes covering that division of physical chemistry which deals with the relations between chemical and electrical energy. This new revision has given the author an opportunity to bring the treatment of many topics into harmony with the recent advances in theoretical electrochemistry. It has necessitated the rewriting of many parts and the addition of new material. In order to prevent enlarging the book, some sections that appeared in the earlier editions have been omitted, and while it is unfortunate that this was necessary, the loss has been more than offset by the gain.

The second volume, which deals with applications of electrochemistry although written primarily for students in universities and technical institutions, should prove to be a useful reference book for engineers in industry. The author, although thoroughly familiar with electrochemistry, has had the added advantage of the cooperation and suggestions of a large number of successful industrial electrochemists who are specialists in the various divisions of the subject. It has been necessary to limit discussion of each topic so that the book would not be too voluminous for use as a textbook, but numerous references to the literature have been supplied for those who want to go into the subject in greater detail. The busy engineer should find this style of treatment pleasing. The text is unusually well illustrated and contains many helpful tabulations.

Among the subjects discussed are: economics of power generation, primary and secondary cells, electroplating, electro-refining, electro-metallurgy, electrolysis of alkali halids, corrosion, electro-analysis, furnaces, electronics, fixation of atmospheric nitrogen, separation by electrical means, and miscellaneous electrochemical processes.

GALVANIZING, 2ND EDITION. By *Heinz Bablik.* Translated by Margaret Juers-Budicky. Published by Engineers Book Shop, New York, N. Y., and E. & F. N. Spon, Ltd., London. 1936. 366 pages. Price, 20 shillings.

THIS BOOK has grown out of the author's small treatise "On the Galvanizing of Iron" which was published in Vienna in 1924 and which, enriched by the result of research work, has reached its present form through the books "Galvanizing" (London and New York, 1926), "La Galvanization du Fer" (Paris, 1927), and "Grundlager des Verzinkeus" (Berlin, 1930).

The aim of the author has been to offer the galvanizer practical technical knowledge that will be a guide to the correct or most satisfactory method of working under any possible conditions. The first edition has been completely rewritten and greatly enlarged. It now includes a chapter on sprayed metal.

Metallurgical Production and Use

AN INTRODUCTION TO THE METALLURGY OF IRON AND STEEL, 2nd Edition. By *H. M. Boylston.* 554 pages, including many illustrations. Published by John Wiley & Sons, Inc., New York. Price, $5.

THIS EDITION has been extensively revised to include at least a brief description of all the important developments that have taken place since 1927 when the original manuscript was prepared. All statistical tables have been brought up to date. In the blast-furnace department a description has been given of the Hopkins electrical rotary mud gun by which it is possible to plug up the tap hole while the furnace is in operation. "Slow blowing" and "fanning" of the blast furnace are briefly mentioned. The new Brackelsberg melting furnace for foundry work and the Byers-Aston Process for producing wrought iron, and certain developments in open-hearth practice have been described.

METALLURGICAL DIALOGUE. By *Albert Sauveur.* Published by American Society for Metals, Cleveland, Ohio. 166 pages. Price, $3.

PROFESSOR SAUVEUR has selected a unique and interesting style in which to educate the student of metallurgy, at Harvard and elsewhere. The dialogue carried on by pupil and instructor is composed for the most part of very brief questions and clear and simple replies, although occasionally the latter require several hundred words. Such usual features as table of contents, index and chapter headings do not appear but they are hardly missed in so small a book and in one in which the subject matter discussed on each page is indicated by a line at the top. The non-technical reader will find the little volume easily understandable and enlightening.

CHROMIUM PLATING. By *Prof. O. Bauer, Prof. H. Arndt* and *Dr. W. Krause,* and translated from the German by *E. W. Parker,* with the introductory chapter in electroplating practice by *A. W. Hothersall.* Published by Longmans, Green & Co., New York. 223 pages plus 30 pages of bibliography. Price, $9.50.

THE introductory chapter covers present day electroplating practice as well as the properties of chromium and nickel coatings. The greater part of the book comprises an amplified translation of a report issued by the Staatliches Materialprufungramt in 1934. It deals with chromium plating with special reference to its use in the automobile industry. The subjects covered include: testing of metal coatings, coatings on the automobile components, surface quality, adhesion, hardness and wear resistance, resistance to high temperature and reversals of temperature, porosity, corrosion tests and tests on experimental chromium-plated samples.

FINISHING METAL PRODUCTS. By *Herbert R. Simonds.* Published by McGraw-Hill Book Co., New York. 322 pages. Price, $3.50.

By *James A. Lee*

BEFORE the depression when money was plentiful, it was easy to sell merchandise regardless of appearance. With the coming of hard times, however, it became much more difficult to persuade the public to part with hard-earned cash. As a result manufacturers turned their attention to lowering costs and to making the appearance of the product more pleasing. Now as business improves, the buyer continues to expect and demand attractively finished articles.

Mr. Simonds, who has had much to do with improving design and finish of numerous metal products, not only discusses the various means of improving finishes available to the manufacturers, but also covers the methods used to accomplish the results. He discusses the commercial aspects of finish and appearance, preparation for the finish of metal products, polishing and buffing, plating and spray coating, painting, and finally special finishes. His audience includes executives, sales managers, product designers, plant engineers and mill operators.

British Plastics

BRITISH PLASTICS YEAR BOOK 1936. Published by Plastics Press Ltd., London. 582 pages.

THE SAME arrangement of sections used in previous years has been retained this year, but the editorial material has again been completely changed. The volume contains: (1) names and addresses of plastic manufacturers in the United States and other countries, (2) trade names of plastic materials, (3) manufacturers and suppliers of raw materials, (4) manufacturers of equipment, and other information.

Fuel Data

TECHNICAL DATA ON FUEL, 4th Edition. Edited by *H. M. Spiers.* Published by the British National Committee of the World Power Conference, 36 Kingsway, London, W.C.2. 374 pages. Price, 13 shillings, postage paid.

THIS handbook will be wanted by all who undertake to maintain a complete library on power and fuels. The data, being of fundamental engineering nature, are in most cases just as applicable to American conditions as to British. The authors of various chapters are men of high standing in the various divisions of the fuel industries of Great Britain, and their data, therefore, command great confidence. In addition to chapters on gaseous, liquid, and solid fuels, and the various chapters giving general information on fundamental energy data, there are important sections which deal with thermal conductivity, metals and alloys, refractories, and other closely related subjects.

WASSERGAS. By *Dr. Paul Dolch.* Verlag Johann A. Barth, Leipzig. 268 pages. Price, 17 Rm.

Reviewed by *A. P. Hartlapp*

THE AUTHOR offers a critical survey of the development of hydrogen generation processes, their importance and present-day usefulness. The book has two parts. The first is an historical presentation of the progress and discoveries in the study of hydrogen generation. It is in itself an interesting example of physical-chemical research into the action of steam in the presence of live solid combustibles. It is noteworthy that the author has drawn upon all the outstanding publications in this field for his material. The second part of the book relates to the technology of hydrogen generation, and gives especial consideration to those processes which have a practical application. Explanatory sketches, tables, and computations complement the text. This book appears to be of special value, not only to the chemist, but also to the gas engineer.

Thorpe Addenda

THORPE'S DICTIONARY OF APPLIED CHEMISTRY. Supplement Vol. 3—Glossary & Index. By *J. E. Thorpe* and *M. A. Whiteley.* Longmans, Green & Co., London and New York, 1936. 166 pp. Price, $8.50.

THE AUTHORS believe that developments during the last ten years since their well known dictionary was published, have called for a series of supplements to bring the major work up to date. Their work will assist in following the latest research in any line, even outside one's own field of activity. A complete index to the three supplement volumes is added.

WOOD HANDBOOK. Prepared by *Forest Products Laboratory.* U. S. Department of Agriculture. 306 pages. Price, 25 cents. Copies may be obtained from Superintendent of Documents, Government Printing Office, Washington, D. C.

THIS is a handbook of basic information on wood as a material of construction with data for its use in design and specifications. It embodies results of 25 years of research by the Forest

Products Laboratory. It treats of all the practical phases of wood use, including the mechanical properties of wood and the facts recently developed in regard to ring placement, fatigue effects, the various factors affecting strength; control of decay and insect damage, classification of woods for painting, timber for outdoor use, preservative treatment, and treating for effective fire resistance. Distinctly modern fields of use are covered in a section on glued, laminated, and composite wood construction.

German Books and Pamphlets

ABFALLSTOFFE DER ANORGANISCH-CHEMISCHEN INDUSTRIE UND IHRE VERWERTUNG. By *Emil J. Fischer.* Theodor Steinkopff, Dresden and Leipzig, 1936. 156 pages. Price, RM. 9.—.

THIS IS Vol. 36 of a series of monographs on chemical engineering. It summarizes the present technique of utilization of waste materials especially in Germany.

DECHEMA WERKSTOFFBLAETTER. By *Dr. E. Rabald.* Verlag Chemie, G.m.b.H. Berlin, 1935. 105 pp. Price, RM. 7.50.

AN INDEX of the world literature up to July 1934 referring to all problems touching materials used in chemical engineering. It not only states the origin of the article but gives a short outline as well. A detailed index makes it easy to find any reference.

FORTSCHRITTE IN DER ANORGANISCH-CHEMISCHEN INDUSTRIE. Vol. IV, Part III (Final Section), 1928-32. By *Adolf Bräuer* and *J. D'Ans,* with the cooperation of *Joseph Reitstötter.* Verlag Julius Springer, Berlin. 1,090 pages. Price, 148 Rm.

Reviewed by *A. P. Hartlapp*

PROGRESS in the German chemical industry is clearly shown by the volume of patents in the field of inorganic chemical technology. The principal idea of the authors was to facilitate the search of the reader, not only in helping him locate special patents, but also in acquainting him with the most pertinent literature, both German and foreign. The reprints of the patents are authoritative and may be relied upon fully.

The book has two main sections, metallic compounds, and metals. To appreciate the magnitude and scope of the present publication, it will be of interest to list a few of the new processes developed, such as the electrolytic treatment of polyhalite for potassium compounds, extraction of rubidium from carnalite, thermal reduction of bauxite, use of beryllium in copper alloys and magnesium in new alloys developed especially for the rayon industry.

GOVERNMENT PUBLICATIONS

Documents are available at prices indicated from Superintendent of Documents, Government Printing Office, Washington, D. C. Send cash or money order; stamps and personal checks not accepted. When no price is indicated pamphlet is free and should be ordered from bureau responsible for its issue.

Anthraco-Silicosis Among Hard Coal Miners, by R. R. Sayers and others. Public Health Service Bulletin 221; 25 cents.

Urinary Excretion of Silica by Persons Exposed to Silica Dust, by J. J. Bloomfield and others. Public Health Service Reprint 1712; 5 cents.

Silicosis as Affecting Mining Workmen and Operations, by D. Harrington. Bureau of Mines Information Circular 6867; mimeographed.

Flotation of Langbeinite From the Potash Field of New Mexico and Texas, by F. D. DeVaney and S. R. B. Cooke. Bureau of Mines Report of Investigations 3300; mimeographed.

Classification Chart of Typical Coals of the United States, by A. C. Fieldner and others. Bureau of Mines Report of Investigations 3296; mimeographed. Showing B.t.u. per pound on the moist, mineral-matter-free basis; plotted against fixed carbon on the dry, mineral-matter-free basis.

Progress Report on Investigation of Detachable Rock-Drill Bits, by McHenry Mosier. Bureau of Mines Information Circular 6877; mimeographed.

Mineral Industries Survey of the United States—Idaho Shoshone County, Coeur D'Alene District, by C. E. Julihn and F. W. Horton. Bureau of Mines Information Circular 6876; mimeographed. The Silver Belt and the Sunshine Mine of the Coeur D'Alene District.

Jade, by Alice V. Petar. Bureau of Mines Information Circular 6844; mimeographed.

Check Determinations of Grindability of Coal by Various Methods, by W. A. Selvig. Bureau of Mines Report of Investigations 3301; mimeographed.

Manufacture of Paraffin Wax From Petroleum, by Ralph H. Espach. Bureau of Mines Bulletin 388; 15 cents.

Laboratory Studies of the Inflammability of Coal Dusts, by A. L. Godbert and H. P. Greenwald. Bureau of Mines Bulletin 389; 5 cents. Effect of fineness of coal and inert dusts on the inflammability of coal dusts.

Preventing Accidents by the Proper Use of Permissible Explosives, by D. Harrington and S. P. Howell. Bureau of Mines Technical Paper 567; 10 cents.

Hazard of Igniting Coal by Electric Circuits in Mines, by H. B. Freeman. Bureau of Mines Technical Paper 568; 5 cents.

Bleaching and Ceramic Clays of Western Tennessee and Kentucky Studied by U. S. Geological Survey, by G. R. Mansfield. Department of Interior Release March 30, 1936; mimeographed.

Preparing Shipments to Europe, by B. O. Weitz and Florence K. Ioannou. Bureau of Foreign and Domestic Commerce Trade Promotion Series 158; 15 cents. Documentary requirements and customs regulations.

Rubber: Some Facts on its History, Production, and Manufacture, by P. W. Barker. Bureau of Foreign and Domestic Commerce; mimeographed.

Permanent Magnet Steel. Bureau of Standards Letter Circular 461; mimeographed. Summary of general principles involved in manufacture and use.

Units of Weight and Measure, Definitions and Tables of Equivalents. Bureau of Standards Miscellaneous Publication 121; 15 cents (superseding Circular 47).

Carbon Brushes (Carbon, Graphite, and Metal-Graphite) and Brush Shunts. Bureau of Standards Simplified Practice Recommendation R56-35; 5 cents.

Statistical Abstract of the United States, 1935. Bureau of Foreign and Domestic Commerce unnumbered book; $1.50 (buckram), 817 pages. Summary of authoritative statistics showing trends in trade and industry.

Foreign Commerce Yearbook 1935. Bureau of Foreign and Domestic Commerce unnumbered book; $1.25 (buckram), 386 pages. Handbook of foreign economic statistics.

Artificial Reforestation in the Southern Pine Region, by Philip C. Wakeley. Department of Agriculture Technical Bulletin 492; 15 cents.

List of Technical Workers in the Department of Agriculture and Outline of Department Functions 1935. Department of Agriculture Miscellaneous Publication 233; 15 cents.

Home Dyeing With Natural Dyes, by Margaret S. Furry and Bess M. Viemont. Department of Agriculture Miscellaneous Publication 230; 5 cents.

The Chemical and Physical Properties of Dry-Land Soils and of Their Colloids, by Irvin C. Brown and Horace G. Byers. Department of Agriculture Technical Bulletin 502; 10 cents.

Subject Index of Tariff Commission Publications. Revised December, 1935. Tariff Commission unnumbered pamphlet; 10 cents.

Foreign Trade of Argentina in 1933 and 1934. Pan American Union Foreign Trade Series 141; 5 cents.

Foreign Trade of Chile for 1933 and 1934. Pan American Union Foreign Trade Series No. 142; 5 cents.

Decisions of the United States Courts Involving Copyright, 1924-1935. Library of Congress, Copyright Office, Bulletin 20; $1.50 (cloth), 947 pages.

Statutes and Decisions Pertaining to the Federal Trade Commission, 1914-1929. Federal Trade Commission, 1241 pages (cloth bound); $2.00. Comprises Federal Trade Act, Clayton Act, Export Trade Act, opinions of United States Attorney General, Sherman Antitrust Act, and marginal references to all amendments to, or acts directly affecting, the above-named statutes.

United States Government Printing Office Style Manual. Revised November, 1935; $1.00 (Cloth).

Federal Specifications. New or revised specifications of the Federal Specifications Board on: Batteries, storage, ignition, lighting and starting, W-B-131a; Soap, toilet, powdered, for dispensers, P-S-626; Acid, oxalic, technical, 0-A-91; Soda, laundry (washing-soda, Amendment 1 to P-S-641; 5 cents each.

Indexes to Specifications. Index to Federal Specifications, Treasury Department, Procurement Division, Section IV, Part 1 to Federal Standard Stock Catalog, Revised to November 1, 1935, 10 cents; Index of Specifications Used by the Navy Department for Naval Stores and Materials, corrected to and including January 2, 1936, available from Bureau of Supplies and Accounts, Navy Department.

Mineral Production Statistics for 1934—Separate statistical appendices to Minerals Yearbook 1935 on: Natural Gasoline; Lime; Ore Concentration; 5 cents each.

Mineral Production Statistics for 1935—preliminary mimeographed statements from Bureau of Mines on: Phosphate rock; aluminum; iron ore.

Your Plant NOTEBOOK

COMPRESSING STEAM FOR PRODUCING HIGHER TEMPERATURES

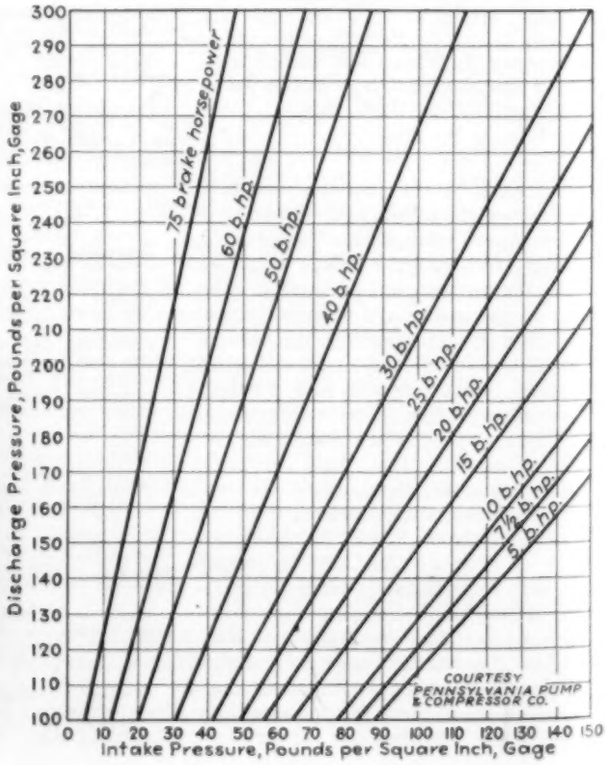
COMPRESSING steam in order to raise its temperature above that at the available boiler pressure is not a new idea but it is one that is now being used to an increasing extent. Such compression is not usually economic in comparison with the generation of steam in a boiler, but it is an expedient that will often prove advantageous where the quantity of steam required at the higher pressure (and temperature) is insufficient to justify changes in or additions to the existing boiler installation. Although the requirement for higher temperature is sometimes met through the superheating of the steam, either at the boiler or in a separately fired superheater, this method has disadvantages, principally in that the temperature control obtainable with superheated steam cannot compare in accuracy with that inherent in saturated steam. It would seem therefore that there must be numerous cases where the most suitable method of securing higher process steam temperature would be through the use of mechanical compression.

Like any other gas, superheated steam falls sharply in temperature as heat is extracted from it. Saturated steam, on the other hand, condenses at constant temperature. Furthermore, the quantity of heat available as latent heat in a pound of saturated steam is much greater than the quantity that can be extracted from a pound of superheated steam for any reasonable temperature drop. For example, 808.5 B.t.u. is available at 417 deg. F. per pound of saturated steam at 300 lb. abs., whereas, with steam at 100 lb. abs., superheated to 600 deg. F., only 92 B.t.u. is available per pound in dropping to 417 deg. F. Finally, much better heat transfer is obtained from a condensing vapor than from a superheated vapor. Process industries, for these reasons, usually prefer not to employ more superheat in process steam than is sufficient to offset radiation losses in transmission from the boiler.

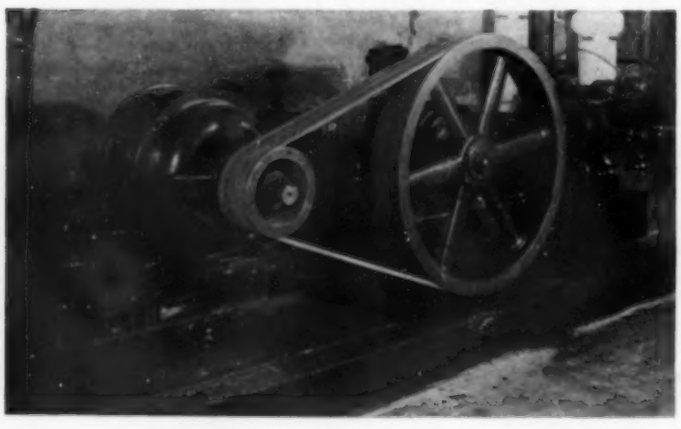
In order to give engineers a ready method for determining the approximate cost of compressing steam from various initial pressures to final pressures in the range from 100 to 300 lb. gage we reproduce herewith a new chart which has been made available through the courtesy of the Pennsylvania Pump & Compressor Co. of Easton, Pa. The chart gives directly the approximate brake horsepower required at the compressor shaft in compressing 1,000 lb. of dry saturated steam per hour from the initial to the final pressure desired. The approximate character of the chart is emphasized since it is obvious that both the mechanical efficiency and the compression efficiency of the compressor selected will vary with the volume of steam being handled.

In constructing the chart the formula used was similar to the familiar one for air compression, employing an average ratio for the specific heats of steam over the range of pressures in which steam compression is practicable. From this fundamental expression the theoretical horsepower for the compression of 100 cu.ft. of dry saturated steam (referred to intake conditions) may be expressed as $1.8995\,P_2\,(R^{0.278}-1)/R$ where P_2 is the final pressure in pounds per square inch abs. and R is the compression ratio. The curves were obtained through the use of this formula, modified for 1,000 lb. of steam per hour and for average values of mechanical and compression efficiency.

Chart for determining approximate brake horsepower at the compressor shaft required in compressing 1,000 lb. of dry saturated steam per hour from various initial to various final pressures



Steam booster compressor raising the pressure of process steam in the plant of a large electrical manufacturer



TRANSFERRING REFRIGERANT GASES TO SMALL CYLINDERS

IN A BULLETIN recently issued to its members, the Compressed Gas Manufacturers' Association described a number of safe methods and precautions for transferring refrigerant gases to small cylinders and other apparatus without the use of elaborate or expensive equipment. The Association does not endorse the practice of making such transfers, but in recognition of the fact that they are being made, recommends certain means of minimizing the attendant dangers.

The bulletin states that unnecessary danger in transferring refrigerant gases is sometimes caused by practices such as filling a cylinder with an excessive quantity of gas, particularly in its liquid phase, or applying a direct flame to a gas cylinder. The Interstate Commerce Commission has prescribed certain acceptable percentage ratios of weight of gas to the water capacity of a pressure cylinder. That is, for every pound of water the cylinder will hold, it may be charged with 0.54 lb. anhydrous ammonia, 1.19 lb. of dichlorodifluoromethane, 0.68 lb. of liquid carbon dioxide, 0.75 lb. of methyl chloride, 0.44 lb. of propylene, and 1.25 lb. of sulphur dioxide.

The bulletin lays emphasis on the hazard of applying a direct flame to a gas cylinder, pointing out that excessive heating of the metal may render the cylinder unsafe for use without its being returned to the cylinder manufacturer for annealing. A further hazard lies in the possibility of melting the fusible plug and permitting escape of refrigerant.

Four safe methods are recommended, including (1) purge method; (2) external cooling method; (3) vacuum pump method; and (4) water bath method. Any of these methods may be used for transferring or expelling relatively low pressure refrigerant gases from cylinders. The purge method is designed to take care of the filling of a cylinder which contains air. The external cooling method is useful when the cylinder is free from air but contains a small quantity of refrigerant. The vacuum pump method is recommended when the cylinder contains air and it is desirable to avoid the small wastage of gas which occurs with the purge method. The water bath method is the only one recommended for expelling the last few pounds of gas from a carbon dioxide cylinder.

Purge Method

To employ the purge method, a heavy wooden rack should be supplied to hold the stock cylinder inverted at an angle of about 30 deg. from the vertical as in Fig. 1. A ¼-in. O.D. flexible copper tube with a loop about 8 to 12 in. in diameter (or flexible armored rubber pressure hose in the case of anhydrous ammonia) should be provided for connection to the small cylinder. A union of the flare-nut type may be used for connecting the tubing to the cylinder valve *A*. A stop valve *B* must be provided and should be of a good refrigeration type. The purge valve *C* may be a three-way valve or a tee in the line, equipped with a ¼-in. globe valve. A platform scale is provided for weighing the small cylinder. This should be accurate to ½ per cent of the water capacity of the receiving vessel.

First the small cylinder is weighed with the tubing connected as shown in the drawing. All four valves are closed. Then valves *A* and *B* are opened and valve *C* cracked until liquid appears at the vent. Then valves *B* and *C* are closed and valves *D* and *B* are opened until about ¼ lb. of refrigerant has been transferred to the receiving cylinder. *B* is then closed. Then valve *C* is opened to blow out the air in the small cylinder. About 15 to 30 seconds of purging is usually ample. This also cools the small cylinder, producing a pressure differential which aids the flow from the large cylinder. After valve *C* is closed, valve *B* is again opened until the scale shows that the correct quantity of the refrigerant has entered the small cylinder. Finally, valves *B* and *D* are closed and *C* opened to release the pressure on the line prior to repeating this cycle with the next cylinder.

The external cooling method makes use of a differential temperature between the large and small cylinders to hasten the transfer of refrigerant. The small cylinder is placed in a container of cold water, ice water or other cooling medium, using the same equipment as the purge method. The copper tube is purged as in the earlier case. Then valve *C* is closed and valve *B* opened until the proper quantity of refrigerant has entered the receiving cylinder. Valves *B* and *D* are then closed and valve *C* opened to discharge the line between *B* and *D*.

Vacuum Pump Method

When the receiving cylinder contains air, the vacuum pump method illustrated in Fig. 2 may be used. The equipment required is the same as that for the purge method except that the suction line of a vacuum pump, equipped with a vacuum gage, is connected to the outlet of the three-way valve or to the free leg of the tee. A tee in the vacuum line for venting purposes is also desirable.

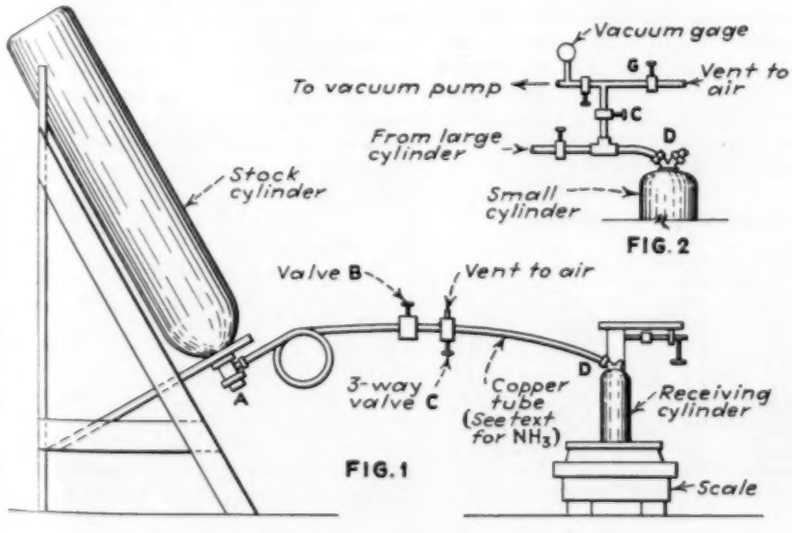
With valve *A* closed and the other valves open, the pump is first used to evacuate the charging line and cylinder. Then *C* and *B* are closed and valves *A* and *B* opened. When the correct quantity of refrigerant has run into the receiving cylinder, valves *B* and *D* are closed and valve *C* and vent valve *G* opened, permitting escape of the liquid refrigerant between stop valve *B* and the receiving valve *D*. When the next cylinder is evacuated, valve *B* should be closed since the charging tube between *A* and *B* now contains liquid refrigerant.

It is important to avoid suction of the refrigerant into the vacuum pump.

The final or water bath method consists in placing the stock cylinder upright in a water bath about 10 or 12 in. deep and heating the water with low pressure steam to a temperature not exceeding 125 deg. F. Not more than 20 per cent of the cylinder surface should be under water.

Fig. 1—Equipment required for transferring refrigerant gases to receiving cylinders

Fig. 2—Vacuum pump connections for removing air from lines and cylinder



News of EQUIPMENT

New motorized variable speed drive

Small Tube Cleaner

For the ready cleaning of small tubes, as in condensers and heat exchangers, the Roto Co., 145 Sussex Ave., Newark, N. J., has developed a new Roto Junior tube cleaner for straight tubes as small as $\frac{5}{8}$ in. O.D. and curved tubes as small as $\frac{7}{8}$ in. O.D., with short radius bends.

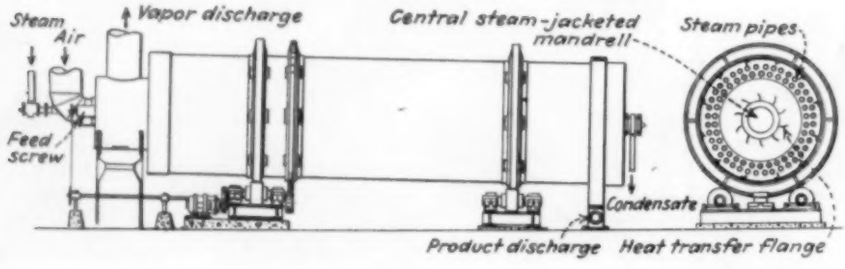
The new cleaner is simple and self-contained, consisting of a tiny air motor and scraper head which are pushed into the tube by means of the air hose. A quick-opening air valve attached to the rear of the motor by a short section of hose is arranged so that a 45-deg. turn shuts off the air when the cleaner is removed from one tube and inserted into another. The device is readily operated by one man. The equipment includes the motor, a sight-feed lubricator with 25 ft. of operating hose, the quick-acting air valve, two cone cutters and a scraper head with an extra set of scraper blades.

Rotary Steam Dryer

What is believed by the manufacturers to be an important development in steam heated dryers is the use in the new Tyler-Harmor steam dryer of a hot central heating mandrel, similar to that used in the direct-heat dryer of the same make. The new dryer, built by the W. S. Tyler Co., Cleveland, Ohio, is shown in elevation and cross section in the accompanying drawing. It will be seen to consist of a rotary shell within which are numerous steam pipes placed near the periphery. In the center of the shell is a steam jacketed pipe through which the drying air is led before it enters the shell proper. Material, introduced at the higher end by means of a screw, is lifted by heat transfer fins attached to the heating mandrel and cascaded through the steam pipes, meanwhile being subjected to contact with air preheated by passage through the central mandrel. As will be noted, the material travels from left to right, while the air travels counter to it, discharging at the left end of the equipment.

This construction is said greatly to increase the heat transfer surface, while at the same time it delivers preheated air of high moisture absorbing capacity to the drying chamber. If desired, air may receive its initial preheat outside the dryer in the form of waste heat from some other operation. The use of the heat transfer fins to lift and shower the material, it is pointed out, doubles the number of times the material is dropped through the air stream, increasing the aeration of the material and constantly exposing new surfaces. Dryer sizes range from 18 to 28 ft. in length and from 62 to 102 in. in diameter.

Steam heated rotary dryer with central steam heated mandrel



Variable Speed Drive

Any constant speed motor meeting standard NEMA dimensions may be used with a new self contained variable speed drive that has been introduced by the Reeves Pulley Co., Columbus, Ind. This device, known as the Vari-Speed Motodrive, makes possible infinite speed variation within predetermined limits. A dial indicator registers speed on a scale calibrated from 1 to 6.

The new drive combines features of two of this concern's earlier developments, the standard Reeves drive and the Vari-Speed motor pulley. It employs a V-belt running between two sets of cone-faced disks which are adjustable in diameter and mounted on parallel shafts. The diameter of the driven pulley is controlled manually as in the case of the standard Reeves, while that of the variable speed pulley is controlled by spring pressure as in the case of the Vari-Speed motor pulley.

Two types, one horizontal, one vertical, are available in capacities from $\frac{1}{4}$ to $7\frac{1}{2}$ hp. By the use of helical reduction gearing integrally mounted, almost any speed variation of the output shaft in practically any desired range can be obtained.

Equipment Briefs

To facilitate searching for buried pipes the General Electric Co., Schenectady, N. Y., has developed a new magnetic detector said to be of extreme sensitivity and accuracy. In locating certain pipes laid over 40 years ago, it is stated that the new detector found them at depths up to 7 ft. and as far as 100 ft. from their supposed location, indicating their presence within one diameter of the pipe. The equipment may be used for locating magnetic pipe, while for pipe of non-magnetic metals, it can be used if a current can be passed through the pipe. It consists of a surveying compass with an adjustable bar magnet for controlling the effects of the earth's magnetic field. Affixed to the compass box and turning with it are two radial fins of high permeability, low hysteresis material which serve as magnetic antennae.

Kron Scale Co., Bridgeport, Conn., has recently developed a new small bench scale for general utility use, the platform of which measures $16\frac{1}{2}$x$18\frac{1}{2}$ in., with capacity from 50 to 125 lb. The platform is of this company's standard full floating design and the dial mechanism a smaller size of the standard Kron double pendulum ball bearing type. All levers operate about fixed fulcrums

so that pivots and bearings wear only when a load is actually being weighed.

Commercial production of a new line of seamless tubes and pipe of 25 per cent chrome, 20 per cent nickel steel has been announced by the Babcock & Wilcox Tube Co., Beaver Falls, Pa. These products are available hot-finished in sizes up to 6 in. O. D., and cold drawn, in smaller sizes. The new alloy, known as B&W Croloy 25-20, is said to exhibit a high degree of oxidation resistance, being suitable for continuous operation at temperatures as high as 2,100 deg. F. It is reported to possess superior creep strength.

A new jointing compound for water mains, recently introduced by Atlas Mineral Products Co., Mertztown, Pa., has been given the name "Tegul Mineralead." The new compound has been shown in tests to produce tight joints immediately, permitting the trench to be filled at once. It is recommended by the makers for jointing ceramic and terra cotta pipe and is understood to be a special form of sulphur cement.

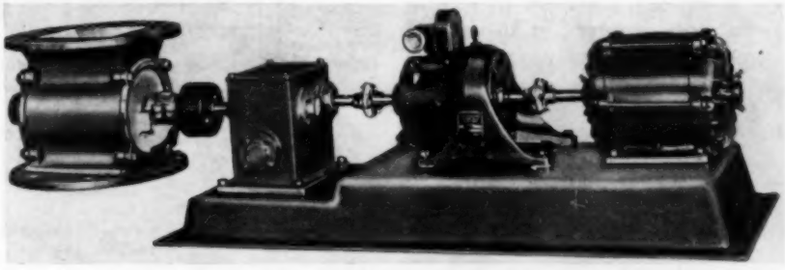
For the handling of small quantities of liquids at fairly high pressures, Homestead Valve Mfg. Co., Coraopolis, Pa., has developed a miniature triplex plunger reciprocating pump with a capacity, depending on speed, from 15 to 120 g.p.h. A ¼-hp. motor will operate the pump at 60 g.p.h. and 200 lb. pressure. The three cylinders have bores of ¾ in. and ⅝ in. stroke. The inlet valves are of Monel metal, and are of the poppet type, positively actuated through a cam. The outlet check valves are of the ball type. All gears, cranks and connecting rods are inclosed in a crankcase with splash lubrication.

Spence Engineering Co., Walden, N. Y., has announced a new method of making the joint between the seat ring and the body of high-pressure valves. This method, known as "Secoweld," consists in welding a separate ring of Seco metal into the body and threading into this the regular Seco metal seat ring. As this metal is said to withstand the wire-drawing action of steam, in case a slight leak occurs, it will not damage the thread.

Breathing Devices

An improved design of combination hose mask, which has been tested and approved by the U. S. Bureau of Mines, has been placed on the market by the Mines Safety Appliances Co., Pittsburgh, Pa. The principal improvement is in the blower which is supplied with a double outlet for either one- or two-man use. The new blower has increased air capacity, providing sufficient air for two men with up to 150 ft. of hose per man.

This company has also added a new light-weight, half-hour oxygen breathing apparatus to its line of respiratory equipment. This equipment likewise has Bureau of Mines approval. The new design is said to weigh one-third less and to give greater wearing comfort than earlier designs. Breathing resistance has been materially reduced and the mouthpiece is lighter and fits more snugly. The mask is available in two types, one with a mouthpiece only and the other with a complete facepiece. This mask, of course, operates independently of the outside air, supplying oxygen exactly in accordance with the requirements of the wearer.

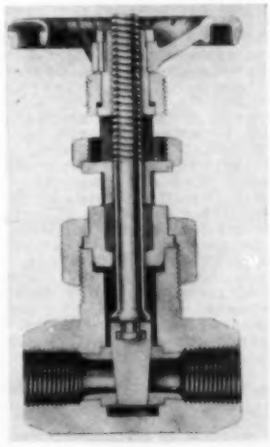


Variable Speed Positive Paddle Type Feeder

Sprout, Waldron & Co., Muncy, Pa., has developed this new variable speed feeder for very fine powdered materials, in a dust-tight design, with the feeder made of cast aluminum. Its speed ranges from 2 to 20 r.p.m., through the use of a New Departure Transitorq and a 200-to-1 speed reducer. The feeder is driven by a ½-hp. explosion-proof motor and has a maximum capacity of 121 cu.in. per revolution.

Steel Gate Valve

An unconditional five-year guarantee is carried by a new line of gate valves, machined from solid steel bar stock, which has been developed by the Chapman Valve Mfg. Co., Indian Orchard, Mass. The new valve, known as List 960, is made in all sizes from ¼ to 2 in. and is designed for all services up to 600 lb. pressure at temperatures to 800 deg. F. Depending on size, the cold working pressures specified are from 1,500 to 2,500 lb. The valve is so versatile that it can, it is stated, be employed as standard small-valve equipment throughout the plant, without the necessity of stocking a variety of types. The valve has no pockets, raised seats or constrictions, forming a virtually unbroken continuation of the pipe line when open. It can be repacked under pressure.



New unconditionally guaranteed valve

For normal service the stem, plug and seat rings are of stainless steel. For special conditions the entire valve is available in Monel metal, stainless steels and other special alloys.

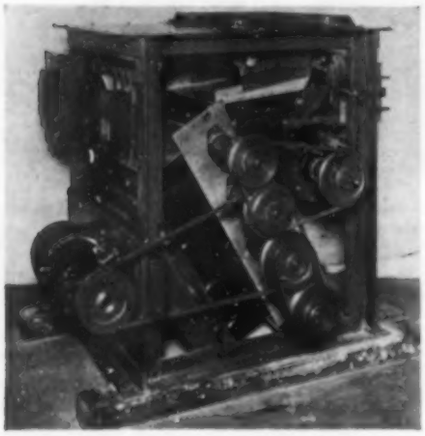
Current Input Controller

Adjustment of electric current supplied to heating elements of furnaces, ovens, platens and other electrically heated units is possible with a series of instruments recently developed and improved by the Automatic Temperature Control Co., 34 East Logan St., Philadelphia, Pa. There are four of these instruments, the basis of which is a switching device which regulates the heat input by the duration of current supply during a constantly recurring cycle, rather than by the use of resistances or rheostats. The device consists of a rotating cam, turned by a synchronous motor which, for a longer or shorter time, causes current to flow through a mercury switch. The duration of contact is adjusted manually in models M and MT and automatically in models F and FL. Model M, which is wired in series with the low contact of the control pyrometer, is the simplest form. Model MT adds a built-in time control for putting the equipment into operation after an adjustable period. Models F and FL automatically adjust the contact interval, the first for installations with but slight furnace lag and the second for those having greater lag.

This company has also recently introduced a new reset time control intended to start electrically a series of consecutive or overlapping operations on a desired schedule. In the event of fuse blowout or other power failures, the unit returns to the original starting position.

Dry Powder Separator

Dings Magnetic Separator Co., Milwaukee, Wis., has announced the development of a new magnetic separator for removing finely divided iron from such materials as enamel powders, feldspar and frit. The new separator, Type CF, utilizes a number of intense magnetic zones arranged in an inclined



Type CF magnetic separator for powders

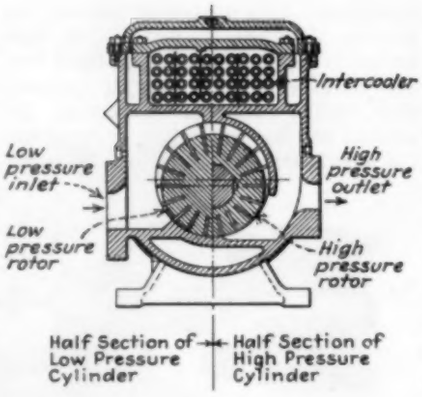
plane, the inclination of which can be varied to suit individual requirements. The zones are stepped to produce the desired cascading effect. A wiper which travels across the face of the magnets is provided to dislodge the iron particles and discharge them to a screw conveyor. A magnetically operated tray feeder is used to secure a uniform feed.

Bomb Samplers

R. P. Cargille, 118 Liberty St., New York City, is distributing two new models of Bacon bomb sampler for sampling tanks and tank cars. Model B is designed to take an average sample. When it is lowered into the tank, liquid flows into the lower end only at the rate that air is displaced from the top through an adjustable needle valve. Model C is designed to take a sample at a point 1 ft. or less from the bottom of the tank. An adjustable plunger extending from the bottom is set for the distance from the bottom desired. The sampler is then lowered until the plunger touches the bottom. This opens the valve and permits the sampler to fill. Liquid is trapped as the sampler is withdrawn.

Rotary Compressor

A new line of the two-stage sliding vane rotary air compressors for pressures up to 100 lb. per square inch gage has been developed by the Allis-Chalmers Mfg. Co., Milwaukee, Wis. The design is unique in that both stages as well as the intercooler are



Two half sections of new rotary compressor

contained within a single casing. In the new design, which has been given the name of "Ro-Twin," both weight and floor space have been reduced. No external air piping is required between stages, the lubrication system has been simplified and only one stuffing box and coupling are required.

As will be clear from the accompanying cross section, the new compressor consists of two rotors sealed by means of sliding vanes carried on and guided by floating rings. The two rotors are on a single shaft, mounted within a casing which likewise contains the intercooler and the interconnecting piping. The only stuffing box is on the low pressure side.

MANUFACTURERS' LATEST PUBLICATIONS

Air Conditioning. Buffalo Forge Co., Buffalo, N. Y.—Bulletin 501—24 pages with extensive selection tables on this company's Type PC cabinets for comfort air conditioning.

Alloys. Hoskins Mfg. Co., Detroit, Mich.—Catalog K—47 pages on this company's alloys for electrical resistance and thermocouples, with tabulated engineering data.

Alloys. Ludlum Steel Co., Watervliet, N. Y.—24-page book, handsomely illustrated, showing applications of this company's stainless steels in a wide range of industrial and consumer applications.

Apparatus. Adam Hilger, Ltd., 98 Kings Road, Camden Road, London, N. W. 1, England—60-page 1936 edition of this company's catalog on spectrographic outfits for metallurgical and chemical analyses.

Boilers. Babcock & Wilcox Co., 85 Liberty St., New York City—24-page booklet describing design and construction of this company's integral furnace boiler.

Chemicals. The Beacon Co., 89 Bickford St., Boston, Mass.—32-page book describing the complete line of emulsifying agents and specialty chemicals for use in emulsions made by this company.

Chemicals. Monsanto Chemical Co., St. Louis, Mo.—55-page booklet listing properties and applications of a wide range of intermediates made by this company. Also booklets issued by this company's Merrimac Chemical Co. subsidiary, including one on anhydrous ferric sulphate as a coagulant, and a series of three booklets on sodium aluminate, its properties and uses in water purification and paper sizing.

Coatings. Kellogg Products Co., 120 Liberty St., New York City—Form G-12—Folder describing a number of corrosion resisting paints for various purposes recently put on the market by this company.

Coatings. Technical Coatings, Inc., 11 Park Place, New York City—10 pages on a series of protective paints developed by this company.

Equipment. Leader Iron Works, Decatur, Ill.—6 pages illustrating types of equipment made by this company from steel, aluminum, nickel, copper and alloys.

Galvanizing. Enterprise Galvanizing Co., 2527 East Cumberland St., Philadelphia, Pa.—4-page leaflet describing this company's facilities for hot-dip galvanizing.

Heat Exchangers. The Duriron Co., Dayton, Ohio—Bulletin 173—Leaflet describing a new Duriron heat exchanger recently developed by this company.

Instruments. Foxboro Co., Foxboro, Mass.—4 pages describing this company's potentiometer Stabilog equipped with a chart and pen to record control deviations.

Instruments. H-B Instrument Co., 2518 North Broad St., Philadelphia, Pa.—Blue Book Part 3—20 pages describing this company's complete line of industrial indicating and recording thermometers.

Instruments. Thermo Control Devices, Inc., 1112 Milwaukee Ave., Chicago, Ill.—Leaflets describing this company's small indicating pyrometers, electronically actuated control pyrometers, and electronically actuated automatic gas shut-offs which operate upon flame failure.

Kettles. Patterson Foundry & Machine Co., East Liverpool, Ohio—Leaflet describing electrically-heated process kettles made by this company.

Lignum-Vitae. Lignum-Vitae Products Corp., 96 Boyd Ave., Jersey City, N. J.—Bulletin 51—Leaflet briefly describing properties of lignum-vitae with descriptions of how this tropical hardwood is used industrially for numerous purposes.

Locomotives. Heisler Locomotive Works, Erie, Pa.—8 pages describing advantages and operation principles of this company's fireless steam-storage locomotives; also describes typical locomotives produced for certain industrial concerns.

Nozzles. Chain Belt Co., Milwaukee, Wis.—Bulletin 278—Briefly describes this company's Rex non-clogging flat spray nozzles.

Plastics. Tennessee Eastman Corp., Kingsport, Tenn.—Edition 3A—52 pages on properties and uses of this company's cellulose acetate molding composition, Tenite.

Power Transmission. Link-Belt Co., 307 North Michigan Ave., Chicago, Ill.—Catalog 1520—40 pages on this company's antifriction bearing units, including pillow blocks, hangers, etc.

Pumps. Ingersoll-Rand Co., 11 Broadway, New York City—Bulletin 1972-A—8 pages on condensation return units employing this company's motorized pumps; Bulletin 2200, 6 pages on the Cameron Motorpump for air conditioning service.

Pumps. Roots-Connersville Blower Corp., Connersville, Ind.—Bulletin 260-B13A—Leaflet describing this company's 300 and 500 g.p.h. water systems comprising a turbine pump direct connected to a motor, with or without a storage tank.

Refractories. Babcock & Wilcox Co., 85 Liberty St., New York City—8-page booklet presenting general characteristics and specific properties of five mortars and plastics made by this company.

Refractories. Mullite Refractories Co., Shelton, Conn.—16 pages describing this company's "Shamva" mullite refractories and cement, with information on applications.

Refractories. The Norton Co., Worcester, Mass.—Folder describing this company's silicon carbide refractory brick.

Tubes. Babcock & Wilcox Co., 85 Liberty St., New York City—Bulletin T-14—16 pages on questions of interest to users of boiler tubes.

Valves. Edward Valve & Mfg. Co., East Chicago, Ind.—Catalog 11-B—25 pages on this company's non-return valves with tables of engineering data and complete construction details.

Water Treatment. W. H. & L. D. Betz, 235 West Wyoming Ave., Philadelphia, Pa.—30-page booklet giving instructions for testing water for hardness, alkalinity, chloride, sulphate, dissolved oxygen and pH, describing testing kits and chemicals.

Welding. Linde Air Products Co., 30 East 42d St., New York City—8 pages on improved methods for fabrication of 18-8 chromium steels, discussing technique and materials.

Chemical Engineering NEWS

Pros and Cons Of Alky-Gas

CONFLICTING viewpoints on the value of alcohol as motor fuel were revealed in four papers read before the joint symposium of the Gas and Fuel, Industrial and Petroleum Divisions of the American Chemical Society at its Kansas City convention, April 13-17. Abstracts of these papers as released by the Society in advance of the symposium are as follows:

Alcohol Gasoline in Motor Fuel. By Gustav Egloff and J. C. Morrell, Universal Oil Products Co., Chicago.

Alcohol-gasoline is a distinctly inferior motor fuel in performance, consumption, and upkeep of motor. Difficult starting, slow acceleration, overheating of engines, and rougher driving can be expected. Increased maintenance cost will result from cylinder and valve wear, all-around corrosion, plugging fuel lines, and dissolving of car varnish. Higher antiknock properties result from blends. Increased fuel consumption will be 60 per cent of the volume of added alcohol. Economically, blending can result only in economic loss to society, and additional unestimated losses will result to the country at large from the political, moral, and health hazards.

Alcohol-Gasoline Blends. By Leo M. Christensen, Iowa State College, Ames, Ia.

During the past fifteen years there has been a very rapid expansion in the use of alcohol in motor fuel. Ethanol is most commonly used but methanol, isopropanol, and isobutanol have also been studied and to a small extent have been commercially employed, particularly in the formulation of racing fuels. Ethanol-gasoline blends containing 5 to 25 per cent of anhydrous ethanol by volume are the fuels most commonly used. These blends are used interchangeably with gasoline of equal antiknock value and have found favor among consumers. The economic status of ethanol used in these blends is established by its antiknock value and other favorable properties rather than by its value as a fuel alone. In many countries the economic analysis must also give consideration to the importance of power alcohol to agriculture and labor, its bearing upon national self-sufficiency, its relation to dwindling petroleum supplies and other national economic and sociological problems. There are no technical obstacles in the way of a large power alcohol development in the United States and there is little doubt that such a program will develop. There are, however, problems in the establishment of adequate acreages of suitable crops and others of similar nature which will have to be worked out during the first stages of the development of a power alcohol industry.

The Utilization of Ethyl Alcohol-Gasoline Blends as Motor Fuels. By Oscar C. Bridgeman.

Technical aspects of blending alcohol and gasoline show, in general, that no significant change in mileage occurs with 10 per cent or less of alcohol. With 30 to 40 per cent there is increased fuel consumption. With unchanged carburetor setting alcohol blends result in loss of acceleration. With 10 per cent alcohol blend, acceleration can be retained by readjusting carburetor, increasing fuel oil consumption about 4 per cent.

Depending on properties of gasoline, 10 per cent alcohol increases octane number from two to ten units, but increases volatility to extent that in hot weather butane content of gasoline would have to be decreased about 2 per cent. Alcohol with a slight amount of water will blend in summertime but not in winter. Condensation of water from air might produce separation of alcohol in automobile tank. This is the most serious problem in handling alcohol.

The Performance of Engines With Gasoline and Alcohol as Fuels. By L. C. Lichty and E. J. Ziurys.

Theoretical analysis shows ideal possibilities ranging from 2.0 per cent increase in power with gasoline compared to pure alcohol, to 8.6 per cent increase with pure alcohol compared to gasoline, depending upon mixture conditions. The water in 190 proof ethyl alcohol is shown to have negligible effect in power and fuel consumption.

Tests on a variable compression single-cylinder C.F.R. engine and on a 1935 Chevrolet engine under various conditions show a small average increase in power (not much more than experimental error involved) in favor of the 190 proof alcohol. However, the specific fuel consumption with 190 proof alcohol is about 60 per cent higher on a weight basis, and about 50 per cent higher on a volume basis than with gasoline.

Soy Bean Possibilities To Be Studied

TWELVE states in the North Central section of the country, acting with the Department of Agriculture experts, have opened a new experimental industrial research laboratory at Urbana, Ill., to delve into the possibilities of the soy bean. This action has been taken following what is the largest jump in production of the bean crop in this country.

The States in the cooperative movement are: Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Nebraska, Kansas, Missouri and the two Dakotas.

Dr. O. E. May of the Bureau of Chemistry and Soils is in charge of the laboratory, while the breeding work will be done under the supervision of W. J. Morse of the Bureau of Plant Industry, who has won a good deal of attention by the work he has done in developing soy beans into a major crop in the United States.

The immediate objectives of the laboratory are improvement of present industrial uses and the development of new uses for the bean, additional facts regarding the effects of different processes on the quality and quantity of soy bean products, and the testing of varieties of the bean for adaptability to various industrial purposes.

Soy beans now are being used in making food and industrial products such as paint, enamel, varnish, glue, printing ink, rubber substitutes, linoleum, insecticides, plastics, glycerin, flour, breakfast food, candies, livestock feeds and soy sauce.

The new laboratory is one of those authorized by the Bankhead-Jones Act of 1935, providing for the establishment of such laboratories in agricultural regions.

Oil Trades Association Elects Officers

ANNUAL meeting of the Oil Trades Association of New York was held in the roof garden of the Waldorf-Astoria Hotel, New York, on the evening of March 24. Following the annual dinner, a business meeting was held at which officers and directors for the ensuing year were elected as follows: president, Rudolph G. Sonneborn; vice-president, Charles V. Bacon; secretary, Joseph C. Smith; treasurer, Philip C. Meon. Directors: Charles V. Bacon, John W. Baker, J. A. Britton, Jr., George E. Getchell, Dart E. Hoffman, Philip C. Meon, W. M. Osborn, Kenneth L. Patterson, John F. Renick, Joseph C. Smith, Rudolph G. Sonneborn, Albert L. Squier and Homer F. Wilhelm.

NEWS FROM WASHINGTON

Washington News Bureau
McGraw-Hill Publishing Co.
Paul Wooton, Chief

TAXES ON process industry seem sure. Those who interpret current activities of Congress with respect to corporation taxes as promising relief from such burdens are doomed to disappointment. All of the intermediate stages of legislative discussion represent merely muddled thinking in public, which ultimately will come back to inevitable fundamentals, which mean that business must pay more to Government next year than last.

Perhaps large stable business enterprises, which already have accumulated surpluses, may temporarily benefit in their competitive relations with small companies. But if such effect of the new law when enacted could be convincingly demonstrated, then the next Congress would be sure to try to modify that effect and reverse such trend. It may be too late to save some of the small companies in the meantime irreparably damaged, but no one should think that Congress is going to allow any continuance of any scheme of taxation that unduly encourages bigness. Congress in this particular is less radical than the President. But it is not for bigness, as against smallness, in business.

Sugar "Monopoly"

The Sugar Institute, before the Supreme Court, lost out in its effort to compel adherence to announced prices. Most impartial onlookers expected no other finding. But these same neutral observers appear generally to be pleased with the decision as more clearly defining than ever before what are legitimate functions of trade associations with respect to stabilization of market conditions.

The Court seems clearly to authorize by this latest anti-trust finding the continuance of open price agreements and the encouragement of price stabilization when this does not amount to coercion of non-conformers or unduly discourage competition. It is to be expected that the Federal Trade Commission will, under the terms of this decision, proceed to authorize some of the pending trade agreements which have apparently been withheld until the Court should speak in this particular case. Among others the fertilizer industry remains, early in April, hopeful that its set of trade practice definitions can now have official approval.

Fuel Competition

Federal activities are consistently trending more to a recognition of the inevitable competition between fuels and other energy supply. It is even contemplated that a fundamental study will be made of the trends with respect to coal, oil, gas, and hydroelectric power. Little more than a reconnaissance can be accomplished in the remaining months of this fiscal year, but it is hoped by those advocating such a project that sufficient progress will be made to assure further allotment of funds for continuance. Engineers of process industry would, of course, welcome the facts that can be so developed. But nothing startlingly new is to be expected.

Alcohol as a source of energy is at the bottom of the list of important projects. Apparently the aid of Chemical Foundation for experimental manufacture in Kansas (*Chem. and Met.*, March, p. 157) makes Government support both unnecessary and unlikely for the present. Some onlookers say that this is very fortunate. They argue that in such an isolated case, with subsidies of a known amount from a known source, it will be possible to determine the facts of costs which might not be feasible with Government subsidies that might be either hidden or of uncertain size.

Favorable Fertilizer Prospects

Fertilizer interests are optimistic over the prospects held out for their industry by the new farm program. They have been doing some intensive study of the program, and the general belief is that "there are big profits ahead for the fertilizer men, if they will just behave themselves."

The new program wins acclaim from several different angles. Those who are in a position to feel confident in the validity of their opinions are convinced that it cannot fail to increase demands for fertilizer. This belief is particularly strong when applied to the program demand for soil improvement crops, which will require largely increased supplies of fertilizer.

Soil erosion phases of the proposal also encourage the fertilizer representatives, for those phases are regarded as veritable bonanzas for the industry as a whole. It is, of course, pointed out that it will be impossible to grow the large covering crops needed by the government's plans, without the aid of augmented plant food materials.

The chief benefit of the new program as it is envisioned, is that it will broaden the scope of the old law, reaching out to the Northeastern farmers, who, with the exception of the tobacco growers, received little assistance under the former law.

Fertilizer manufacturers should also benefit by the retention of the old law's marketing agreement for perishable crops, for there should be marked increase in the use of fertilizers in the truck and fruit branches of farming.

One feature of the program is receiving much attention by the experts in Washington. It is being stressed there that even the small sum of $10 per acre permitted by the act will result in the withdrawal of from fifteen to twenty million acres of sub-marginal land from cultivation, thus throwing an additional load on the land remaining in use, and forcing added fertilization.

In speaking of the program, Charles T. Brand, executive of the National Fertilizer Association, had this to say: "The program contains marvelous possibilities. Whether the fertilizer industry shows the tremendous possible profits, depends entirely on its own conduct. The purchasing power of the farmer is made reasonably good. The market is expanding, and the opportunity for profits are there if evil business practices do not destroy it."

Stream Pollution Bills

Challenged by the proposed water pollution bills fathered by Senator Lonergan, of Connecticut, the Manufacturing Chemists' Association sent a representative before the subcommittee of the Senate Committee on Finance.

Sheppard T. Powell was spokesman for the association and wasted no time in attacking the proposed measures, S. 3958 and S. 3959. Confessing without reservation the need for meeting the increasingly serious problems of stream pollution and the desirability for remedial measures, he assailed the governmental feature of the pending bills.

"The proposed legislation," he declared, "would vitally and detrimentally affect the normal functioning" of the chemical plants operated by the members of his association, "many of which must discharge certain byproducts into surface water."

That the chemical industry has a definite desire to cope with the pollution problem and is doing what can be done to solve it, was evidenced, he asserted, by the expenditure of at least $22,000,000 for disposal plants in 23 states.

Elaborating on that theme he pointed out that to his personal knowledge one

chemical company has spent approximately $1,000,000 for the removal of organic matter; an oil refinery has recently installed a complete plant for treatment of liquid wastes at a cost of $900,000, while a chemical company in the West has recently invested $2,000,000 to be used for prevention of stream pollution.

"Within the past two years," he added, "two distilleries, not affiliated with the group I am representing, have installed completed treatment works, the investment for which was approximately $300,000."

In dealing with factors which have hampered the fight against pollution by industrial wastes, Powell declared that the more important of them are to be found in the lack of a comprehensive program for pollution prevention by municipalities, inadequate cooperation between cities and industries, unfair competition arising from unequal burdens imposed by pollution regulations, and the absence of any really satisfactory means of treatment for a number of industrial wastes.

Control of these factors, which is essential in the solving of the pollution problem, can best be obtained, he thought, by intelligent planning and coordination between industry and the regulatory groups in the areas affected.

"There is little hope," he continued, "of accomplishing the control over these factors by drastic regulatory laws and the creation of the sweeping powers proposed in these bills."

Price Control

The Department of Justice was asked to find out why "the fertilizer trust" violated anti-trust laws in its price control. This suggestion came from Representative Tarver, of Georgia, during appropriation hearings when Assistant Attorney Dickinson was asking for funds and authority to establish a new section in the Department of Justice for economic investigation of industrial activities. Well informed individuals, of course, were amused that there should be even a suggestion of price collusion just now when the fertilizer industry is in the midst of an old-fashioned price cutting war. Later inquiries disclose the fact that the Department does not anticipate making any fertilizer study.

But the Department would very much like to have an economic section made up of skilled investigators as a part of its anti-trust division. This group would, if authorized, investigate complaints of a minor sort and make studies of actual practice in the important industries as a basis for formal departmental action. D.J. would like very much to do work of this sort instead of awaiting findings of the Federal Trade Commission, now the only governmental authority fully staffed for such economic probing of business.

Evidently the House members concerned did not think another investigatory body was required. The requested fund of $100,000 per year was not included when the committee reported its appropriation recommendations to the House. The idea, however, is likely to be considered again; and, with the present trend of official thinking, it will not be surprising if ultimately another agency for anti-trust studies is established.

Price Regulation

An epidemic of proposals for governmental interference with industry in fixing the prices for its goods, seems now to be raging in Washington. Specific proposals do not mean so much, but collectively the significance is important. Among recent activities are the following:

1. Renewed recommendations of the coordinator for industrial cooperation, George L. Berry "NRA successor," undertaking to define unfair trade practices.

2. Federal Trade Commission cease and desist order against Goodyear Tire, forbidding manufacture of All State tires for Sears Roebuck on a cost-plus basis.

3. Report of Federal Trade Commission criticizing the zone price formula of the range boiler industry which uses the basing point principle in pricing its goods.

4. Aggressive Congressional study of the Wheeler bill to forbid steel pricing on the basing point system.

5. Continued pressure for other price discrimination bills with prospect that the Van Nuys proposal will supersede the Patman-Robinson plan.

These Washington activities are not a little encouraged by the various state and state court findings. Washington notes with particular concern the decisions of California courts which, in effect, forbid retailers to sell any products below the price set by its manufacturer.

If the present trend continues in Washington and is encouraged at state capitols, it is evident that pricing of goods will soon be regulated much after the fashion of non-competitive public-utility services.

T.V.A. during the past month has reported to Congress regarding a comprehensive development of the Tennessee River which it proposes to carry out during the next five years. Of course it would like to have the money made available soon; but the funds already authorized are adequate for advance of the more urgent projects, and it is not likely that new appropriations will be vigorously pressed for this Session.

It is not likely that any of the other "river valley authorities" will be authorized. Senator Norris, seeking one for the Mississippi, is perhaps in most advanced position tactically, but even he probably does not expect legislative approval this year. It is too easy to cite against his and the other proposals the fact that Government power projects already under way contemplate an ultimate cost of $1.2 billion, with ultimate development of approximately 8 million h.p. The coal industry also opposes the project vigorously.

Sugar Quotas

Increase in the sugar quotas for 1936 is more than likely in view of the figures gathered by the sugar section of the AAA. As yet however, Secretary Wallace has taken no definite step toward enlarging the quotas.

Under the terms of the Jones-Costigan Act, which provide for revision of the consumption estimate at such intervals as the Secretary may find required, the AAA recently compiled statistics which showed definitely a marked upward trend in sugar consumption. It is now anticipated that consumption for the current calendar year will equal that of 1935, some 6,632,516 tons, raw value. This compares with an estimate of 6,434,088 tons, raw value, made by the department in December.

Two of the paragraphs of the Supreme Court finding of March 30 are particularly significant.

"The restrictions imposed by the Sherman Act are not mechanical or artificial. We have repeatedly said they set up the essential standard of reasonableness. . . . . Designed to frustrate unreasonable restraints, they do not prevent the adoption of reasonable means to protect interstate commerce from destructive or injurious practices and to promote competition upon a sound basis. Voluntary action to end abuses and to foster fair competitive opportunities in the public interest may be more effective than legal processes. And cooperative endeavor may appropriately have wider objectives than merely the removal of evils which are infractions of positive law. Nor does the fact that the correction of abuses may tend to stabilize a business, or to produce fairer price levels, require that an effort to correct them should for that reason alone be stamped as an unreasonable restraint of trade."

"The freedom of concerted action to improve conditions has an obvious limitation. The end does not justify illegal ends. The endeavor to put a stop to illicit practices must not itself become illicit. As the statute draws the line at unreasonable restraints, a cooperative endeavor which transgresses that line cannot justify itself by pointing to evils afflicting the industry or to a laudable purpose to remove them."

NEW STEEL ALLOYS DEVELOPED IN GERMANY IN LAST FEW YEARS

FROM OUR BERLIN CORRESPONDENT

THE BEST known and most widely used heat resistant ferrous alloys usually depend on a base of chromium or of chromium and nickel. In order to attain high resistance at temperatures over 900 deg. C. a large quantity of these elements is necessary. These special steels are not always economical because of the difficulty of heat-treating them, especially in manufacturing seamless tubes. New steel alloys based on chromium and aluminum have been developed in Germany during the last few years. These steels are not capable of being hardened it is true, but they show excellent economy and possibilities of ease of heat treatment. Therefore, seamless tubes may be manufactured from these alloys. The new materials are supplied in several grades to withstand 550, 650, 900 or 1200 deg. C. The formation of an adhesive protective layer of alumina gives the alloys high resistance to oxidizing gases.

Moreover they are resistant to reducing gases. This is due to diminishing diffusibility for carbon and carbon dioxide by the aluminum dissolved in the ferrite—in contrast to chromium and chromium-nickel alloy which absorb carbon more readily. Further, these alloys are superior to most metals because of their resistance to sulphur-containing gases. They may be electrically welded. Another advantage of these steels is the high yield point at elevated temperatures. In consequence of this property it is possible to reduce the wall thickness of tubes and the cross section of sheet metal simultaneously with a higher coefficient of safety. The new tubes give a higher heat transmission and therefore greater economy by diminishing consumption of coal, gas or steam.

The recent use of very high pressure steam has encouraged the use of these special steels. These products may be heat treated without difficulty at temperatures of 1100-800 deg. C. They are used in the construction of chemical and other high pressure equipment, particularly for pressure tubes, coils, oil lines, and sheets for wall temperatures up to 650 deg. C. The alloy containing from 4 to 6 per cent chromium shows a high corrosion-resistance to nearly all chemicals. In order to increase its stability at high temperatures, a small amount of molybdenum is generally added. A steel containing from 13 to 16 per cent chromium is used for temperatures up to 900 deg. C. if it is necessary to resist acid, sea-water, alkalis, glycerine, fatty acids, salts, and for cracking and hydrogenation purposes. For hydrogenation and ammonia synthesis the steel alloy with chromium, aluminum, molybdenum and vanadium is suggested.

Dr. R. Heinze, leader of the Institute for lignite and mineral oil research (Techn. Hochschule, Berlin) referred recently to the employment of tar oil from German lignites for fuel. Bituminous lignites are especially adapted for conversion into fuel. Of the 157 million tons shipped in 1935 in Middle-Germany only 4.2 million tons have been distilled. These 4.2 million gave 278,000 tons of elementary mineral oils and 197,000 tons of these oils were distilled with 19,000 tons additional purchased in special plants. They furnished 15,000 tons of motor fuel and 36,000 tons of diesel fuel, while 100,000 tons were changed into fuel oil, that may be improved to diesel fuel according to recently developed processes.

Eloxal, an electrolytically oxidized aluminum, may be reported as a new material. The artificially produced layer of alumina varies in its texture according to producing conditions, as solution, temperature, tension, time of treatment, etc. By employing appropriate conditions it may follow that the surface becomes immune to atmospheric humidity, against acids and weak alkaline solutions. The fear that inevitable porosity may injure the protective value of the surface was proved to be insignificant. The covering sheets absorb corrosive solutions by capillary attraction, but they form a protective gas-sheet by reaction with the base metal. The gas bubbles are not able to disappear because of the smallness of the pores. This is the reason for the desirability of eloxal as a construction material for the chemical industry, for refrigerators, for tanks, etc. The pores of the covering sheet may be filled with protecting materials selected in such a manner as to be particularly resistant against the respective corroding substances, e.g. with silicates. The "eloxed" elements of construction can not be welded or soldered, therefore they must be fashioned before the eloxation. Combining of the elements by riveting is possible after the eloxation.

An interesting new dyestuff is the "Monastrol Echtblau BS" of the I. G. Farbenindustrie. It belongs to the class of phthalocyanines and contains copper or other metals. It can be heated up to 500 deg. C. without change. This is particularly important for the dyeing of synthetic resins which are fashioned by pressure at high temperature. Moreover this pigment is resistent against acids (with exception of nitric acid and acid oxidizing substances) against alkalis and organic solvents as well as against atmospheric and light effects.

A research plant for producing fatty acids from paraffinic hydrocarbons (called Deutsche Fettsäurewerke, Witten/Ruhr) seeks to develop the synthesis of fats. There are several processes for oxidation of mineral oils known since the war, one or the other of them may now be improved in order to diminish the scarcity of domestic fats.

Refining of the so-called Dogger ores of southern Germany is planned by the "Arbeitsgemeinschaft Neunkirchen-Völklingen." Independent of this company the Röchling Co. has developed a process, which is now being tried at an experimental plant. The poor ores are worked off in a blast furnace without mixture of lime or manganese ores. The obtained crude iron is said to be low in manganese and rich in sulphur. After desulphurizing it is blown with lime according to the Thomas process.

Fluorescent compounds are light-transformers. This property has been examined by Dr. Riehl (Auer-Laboratorium). He discovered on isomorphe of zinc sulphide, by which the light of the mercury-vapor-lamp may be transformed in a desired manner. It transforms the ultraviolet rays into red, without reducing in any way the light-yield of the mercury-lamp. In this way it has been possible to increase illumination efficiency of the mercury-vapor-lamp. Simultaneously the disagreeable effect of the lamp, to excite fluorescence of the human skin, has been removed. Compounds have been produced with a relation of 174 per cent of the reflected to the received quantity of light. This is not astonishing as the compound receives not only the visible but also the invisible light of the mercury-lamp. By the reflection more light than hitherto becomes useful for illumination and so the unusual relation of 174 is explained. The Auer Co., with two other German firms, intends to use this discovery for lighting of streets.

Phosphate Rock Institute Closes Local Office

ANNOUNCEMENT is made by the Phosphate Rock Institute that the New York office of the Institute has been closed and that future communications of interest to the members should be addressed to the president, John T. Burrows, 61 Broadway, New York. The action to close the office and discontinue its activities followed resolutions adopted at the annual meeting held on Feb. 10.

Quick Recovery of Industry In Flooded Areas

WITH THE recession of the flood waters in the three industrial sections affected—Pennsylvania, New England, and the Ohio Valley—and with access to plants and buildings again possible, considerable downward revision has been made in the extent of loss sustained. Earlier estimates, based on a superficial survey, had placed the total loss in the three inundated areas as exceeding one-half billion dollars. A later check-up reduces the loss to about a quarter billion dollars. According to a survey made by *Business Week* the loss is divided as follows: homes, 55 per cent; stores, 15 per cent; industrial plants, 13 per cent; public works, 12 per cent; with the loss to utilities taking up the remaining 5 per cent.

So far as the chemical-producing industry is concerned but little direct damage was sustained with warehoused stocks of chemicals constituting the greater part of the loss incurred. Among the chemical-consuming industries, the outcome was less fortunate as not only were large supplies of raw materials destroyed, including chemicals, dyes, paper stock, leather, etc., but also heavy losses were met because of damage to plants and equipment.

The most immediate effect of the flood on the chemical industry was the insistent call for pharmaceuticals, insecticides and disinfectants, and chemicals for water purification. Within a short period, the supply of bleaching powder in sellers' hands was exhausted and producers, in many instances, called back stocks from consumers and rushed them to the stricken sections. Chlorine compounds also were in active demand and with rail deliveries impossible to some areas and with truck shipments hampered by the washing away of numerous bridges, chemical manufacturers made an enviable record in overcoming unusual transportation difficulties.

More than 1,000,000 gallons of disinfectants were shipped in a period of one week to the flood areas to prevent the spread of infection and disease, John H. Wright, secretary of the National Association of Insecticide and Disinfectant Manufacturers, reported on April 3 at a meeting of the directors of the association held in the Hotel Commodore, New York.

Mr. Wright said: "Before the flood waters began to recede the disinfectant industry began to mobilize its resources and ship supplies to strategic points so that there would be no delay in distribution to afflicted areas. Hundreds of trucks were pressed into service and in some States they were given the right of way. Fortunately, the industry keeps a six months' supply of stock on hand and was able to meet the emergency without difficulty, although many plants added extra crews to keep their shipping departments open twenty-four hours a day."

A plant of one of the large chemical companies in Pennsylvania was flooded but not to such an extent as to cause a shut-down. By working day and night, the power plant was kept in operation and supplied not only light and power but also water to the surrounding community. The laboratory of the plant was turned into a commissary department with workers busy 24 hours a day to feed the workers. Later, when the flood reached its peak and all municipal water and power plants over a wide surrounding radius were put out of commission, this plant closed its chemical division in order to divert its power to hospital use.

The most encouraging feature of recent reports is found in the speed with which plants have been or are being rehabilitated. One large rayon plant in the Pennsylvania district is closed and may remain inactive for a further two months but in the majority of cases the affected plants are rapidly approaching normal. Steel mills in the Pittsburgh district are now operating at the highest level of the year. Paper mills in New England were quick to resume work and the same was true for textile plants.

Centrifuge for Colloid Study Installed by DuPont

WHAT is said to be the only Svedberg ultracentrifuge operating outside of Sweden is the one recently installed at the Experimental Station of E. I. duPont de Nemours & Co., Wilmington, Del., and demonstrated there on Mar. 31 by E. O. Kraemer, of the Station staff. Dr. Kraemer explained that the ultracentrifuge is the joint invention of The Svedberg, professor of chemistry at Upsala University, Sweden, and of his former student, J. B. Nichols, now a member of the duPont research department. In the interval since 1923 the speed attainable has been advanced from 3,000 r.p.m. to 160,000 r.p.m., the latter accomplished by Prof. Svedberg in 1934. At this top speed the centrifugal force is 1,100,000 times gravity. However, no centrifuge built to operate at such a speed has been capable of continuous operation, nor has one lasted for any considerable time. The duPont machine, built for the comparatively conservative speed of 60,000 r.p.m., giving a separation force 250,000 times gravity, is expected to last indefinitely.

The alloy-steel centrifuge rotor is elliptical in section, mounted on a massive horizontal shaft on either end of which is a minute turbine operating on oil at 180 lb. pressure. A cell with transparent quartz windows placed near the periphery of the rotor, contains the material to be studied. The rotor during operation is inclosed in a 5-in. steel casing with windows so arranged that a beam of light can be projected through the quartz-inclosed cell. Observations may be made by photographing the cell and its contents. Speed determinations are made by means of a stroboscope which can be sighted on the flashing light transmitted through the cell.

Chief utility of the new device will be in studying "giant" molecules, of which many of the organic substances of current interest are representative. Among these are many of the plastics, natural and synthetic rubber, and proteins. By comparison of photographs taken at definite intervals it is possible to determine the settling rate of colloids or other particles. With this information, in conjunction with other characteristics of the medium and colloidal particles, Stokes law can then be used in the direct determination of the molecular size.

Government Bureau Aids Naval Stores Industry

THE naval stores industry is going through a stage of development and advancement, according to an article prepared by Henry G. Knight, Chief of the Bureau of Chemistry and Soils.

Admitting all the problems of the industry are not yet solved, Dr. Knight points out that much already has been accomplished. The losses sustained by the industry are still appalling, he declares, and adds there is need for a continuance and development of the scientific research the Government has been making to aid the industry to meet the inroads from abroad, and cope on a successful basis with foreign competition.

Naval stores constitute America's most important single item in the field of chemical exports, and Dr. Knight adds that more than one-half of the country's total production is exported.

In pleading for development and continuance of the research work being done by the department, Dr. Knight asserts that proper development of the industry would materially aid the eight southern states from which the bulk of the products come, to conserve their pine forests and to promote their vitally important lumber interests.

Better and safer methods, he stated, will assist the 12,000 gum "farmers," who now get but a portion of their incomes from naval stores, will greatly extend the field of diversified farming, and, if properly managed, return large areas of delinquent land to tree growing, to profit and to a taxable status.

PERSONALITIES

MARSTON T. BOGERT, protessor of organic chemistry at Columbia University, has been awarded the medal of the American Institute of Chemists. It is presented annually for outstanding service to the science of chemistry or the profession of chemist in America. The award is made in recognition of Dr. Bogert's service as a teacher and as an investigator in the field of organic chemistry.

FRANCIS X. FERNEY, formerly chief chemist for Southern Mineral Products Co., has become associated with Bird Machine Works. He will do sales engineering and development work and will make headquarters at South Walpole, Mass.

GUSTAVE KLINKENSTEIN has been elected vice-president and general manager of Maas & Waldstein Co. of Newark, N. J. He has been associated with the company for over 20 years, beginning work as a chemist, and later becoming chief chemist and more recently director of research.

W. J. PORTER resigned his position in the sales department of Warner Chemical Co., New York, to join the Southern Agricultural Chemical Co., a subsidiary of the Tennessee Corp. He will be located in the company's office at Atlanta.

CALENDAR

INTERNATIONAL CHEMICAL ENGINEERING CONGRESS, London, England, June 22-27.

ELECTROCHEMICAL SOCIETY, annual meeting, Cincinnati, Apr. 23-25.

AMERICAN PETROLEUM INSTITUTE, mid-year meeting, Tulsa, Okla., May 13-15.

AMERICAN ELECTRO PLATERS SOCIETY, Cleveland, June 1-4.

AMERICAN PULP & PAPER MILL SUPERINTENDENTS ASSOCIATION, Grand Rapids, Mich., June 24-26.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Atlantic City, June 29-July 3.

AMERICAN LEATHER CHEMISTS ASSOCIATION, Skytop, Pa., June 10-12.

TECHNICAL ASSOCIATION OF THE PULP & PAPER INDUSTRY, Montreal, Aug. 3-6.

NATIONAL METAL CONGRESS AND EXPOSITION, Cleveland, Oct. 19-23.

OLIVER R. WULF, fertilizer investigations division, Bureau of Chemistry and Soils, was awarded the Hillebrand Prize for 1935 for his outstanding report before Washington Chemical Society last year on chemistry of the upper atmosphere. At the award banquet on March 12 Dr. Wulf addressed the Society further on trace constituents in the atmosphere.

THOMAS PARRAN, JR., one of the members of the medical staff of the Public Health Service, has been named as Surgeon General, succeeding in this post Dr. Hugh Cumming, whose appointment expired recently. Dr. Cumming will retire under the age limitations of the service.

ORVILLE E. MAY, of the Bureau of Chemistry and Soils, has been transferred from Washington to Urbana, Ill., where he will shortly take charge of the new industrial laboratory of the Bureau that is to carry out research on new industrial uses for soybeans.

HARRY MILLER of the Department of Agricultural Engineering at the University of Idaho, Moscow, Idaho, resigned on April 1 and has become associated with the Bailor Manufacturing Co. at Atchison, Kansas.

R. G. QUINN, who has been a member of the research staff at Glens Falls, N. Y., of the International Paper Co. is now located with Johns-Manville at Manville, N. J.

PAUL FORTIER, who has been superintendent of the Michigan Paper Co.'s mill at Plainwell, Mich., for several years, has resigned in order to accept the general superintendency of the Everett Pulp & Paper Co.'s mill at Everett, Wash.

WILLIAM B. WIEGAND has been appointed director of research for the Columbia Carbon Co. For several years he has directed the research activities of the associated organization, Binney & Smith Co.

W. S. GILFOIL, formerly professor of physical chemistry and chemical engineering at Loyola University, New Orleans, La., and later a consulting chemist at Lake Providence, La., has returned to the Louisiana Oil Refining Corp. Mr. Gilfoil will be in charge of the lubricating laboratory. He will make headquarters at Shreveport.

Marston T. Bogert

HERBERT J. WOLLNER has been appointed special chemical assistant to the Secretary of the Treasury. He will be located at Washington, D. C.

JOHN F. WILLIAMS, who has been assistant to Dr. Wollner, has been made chief chemist of the newly created Bureau of Customs. Mr. Williams will make his headquarters at Washington but will have charge of the activities of the Customs laboratories located at chief ports of entry.

JOHN R. MATCHETT has been transferred from the Kansas City laboratory of the Treasury Department to Washington. Dr. Matchett will conduct special research work on problems of enforcing the narcotic laws.

SYLVESTER SCHICKTAUZ is another new appointment to the staff of the Treasury Department. He has been conducting research in distillation technique at the Bureau of Standards on a fellowship from the American Petroleum Institute, but henceforth will conduct fundamental research on the theory of alcohol denaturation.

OTTO L. BRAUNS has accepted the superintendency of the sulphite mill of the Algonquin Paper Corp. at Ogdensburg, N. Y. After graduating from the Royal

Institute of Technology at Stockholm, Sweden, Mr. Brauns became associated with the department of industrial chemistry at McGill University, Montreal. Later he became research engineer at the Iroquois Falls, Ont., mill of the Abitibi Power and Paper Co., Ltd. In 1931, he was made assistant chief chemist at the Saulte Ste. Marie mill of the company.

G. F. Hogg is now manager of the naval stores department at Chicago for the Hercules Powder Co. Mr. Hogg graduated from the University of Michigan in 1928 after specializing in chemical engineering. A year later he entered the Hercules laboratory then located at Kenvil, N. J., and in 1930 he was transferred to the naval stores department.

Walter O. Walker who has been in charge of the department of chemistry at Miami University, Miami, Fla., has joined the Ansul Chemical Co., Marinette, Wis., where he has been appointed to direct the research work of the company.

OBITUARY

Ray M. Buss, production manager of the Bryant Paper Co., Kalamazoo, Mich., died at Borgess Hospital in March, after an illness of several weeks. He was 57 years old. Mr. Buss had been with the Bryant organization for 30 years.

William C. Peyton died of pneumonia on April 4 at his home in New York following a brief illness. Mr. Peyton was in his sixty-seventh year.

Born in Santa Cruz, Calif., in 1868 he attended the local schools and was graduated from the University of California in 1887. For many years he served as chemical engineer with the California Powder Works, of which his father, Col. Bernard Peyton, was president. He formed the Peyton Chemical Co. in 1910. Ten years later he merged with another company to form the General Chemical Co. of California, which he sold to the General Chemical Co. of New York. After this transaction Mr. Peyton became president of the Standard Stoker Co.

Harry W. Morse, consulting engineer, died at his home at Stanford University on March 12. Dr. Morse was born in San Diego, Calif., Feb. 25, 1873. He was educated at Stanford and Leipzig Universities. The early years of his professional life were spent teaching at Harvard and University of California. His industrial career included work with the Western Precipitation Co., the American Trona Corp. and the Miami Copper Co. Of late years his interests had taken him into the field of geology and metallurgy where his advice was much sought as an expert in patent cases. He is survived by his wife and children and a host of friends throughout the world.

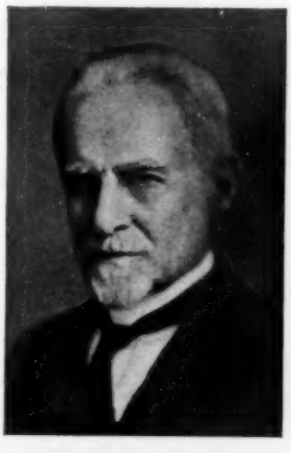
William A. Hamann, formerly president and chairman of the board of Roessler & Hasslacher Chemical Co., now a division of E. I. duPont de Nemours & Co., died March 24, at the age of 75 years. Recently he had been operated on at Miami Beach, Fla.

Mr. Hamann was born in Hoboken, N. J., and at the age of 15 obtained a position with the firm of Frietzsche Bros., New York. In 1885 he became associated with Roessler & Hasslacher and held many positions in the 45 years with the firm.

George A. Prochazka died March 24 of a heart attack in his apartment at the East Orange (N. J.) Hotel. He was 80 years old. He had been associated with the development of the American dyestuffs industry for many years.

A native of Wisconsin, Dr. Prochazka studied chemistry at Koenigs Realgymnasium in Wiesbaden, Germany, the Universities of Heidelberg and Bonn and the Aachen Polytechnic Institute. On returning to this country, he joined the staff of Stevens Institute of Technology, Hoboken, N. J., and later he became staff chemist of the Tartar Chemical Co. of Jersey City. Then he created the dyestuffs department of Heller & Merz Co., New York, and after serving with this concern, together with his brother, John, he founded the Central Dyestuff & Chemical Co., Newark, N. J. He retired in 1924.

George A. Prochazka



Adolf Kuttroff died March 23 at his home in New York. He will long be remembered as a pioneer in the American dyestuff industry. At the time of his death he was a director of the General Dyestuff Corp.

Mr. Kuttroff was born in 1846 at Suiz, Wuerttemberg, Germany, and at the age of 14 came to the United States. His first business experience was with the dyestuff importers, Adolphus Keppelman. He became agent for A. Poirrier of Paris and a year later he founded with William Pickhardt the firm of Pickhardt & Kuttroff. In 1906 the name of the firm was changed to Continental Color & Chemical Co., and later it became the Badenese Co. of New York, which was liquidated in 1917. Mr. Kuttroff continued business under the name of Kuttroff, Pickhardt & Co. In 1925 the General Dyestuff Corp. was formed in which he acted as chairman of the board.

Charles S. Lockwood, of the Hyatt Roller Bearing Co., died in Newark, N. J., on March 20, in his 86th year. He had been associated for many years with Mr. Hyatt and had assisted in the development of sugar cane crushing machinery and other inventions. Mr. Lockwood had served as superintendent of the Celluloid Corp. and the Bonsilate Co.

Henry C. Lomb, a director of Bausch & Lomb Optical Co., Rochester, N. Y., died on March 15 at his home in New York. He was 63 years old.

Michael C. Hall, a chemist for the Standard Oil Co. of New Jersey, for more than 35 years, died on March 17 at his home in Newark, N. J.

Alexander H. Boyd, who perfected several devices used in the electroplating industry, died on March 28 at his home in East Orange, N. J. He was 61 years old. At the time of his death he was New York manager for Hanson, Van Winkle, Munning.

Fred A. Howard died at South Easton, Mass., on March 17. He was 82 years old. Mr. Howard had devoted himself for over 50 years to leather research.

Alfred E. MacIntyre, who attained international repute during the War, died in Ottawa on March 13. He was 72 years old. After the War, he served as chief chemist of the explosives division of the Department of Mines until his retirement in 1931.

Chemical ECONOMICS

ACTIVITIES in the production end of the chemical industry showed an upward swing throughout March and this trend was carried forward into April. Many of the industries which are large consumers of chemicals reported a similar condition although the general improvement was somewhat retarded by the unfavorable conditions which existed in the flooded areas. The outlook for steel production is especially favorable. Many steel plants were affected by the flood waters but two weeks later these plants were operating at 52 per cent of capacity and the rate has since been steadily working upward with 64 per cent of capacity reached in the first week of April and a 70 per cent rate expected before the end of the month and a high level anticipated for the next three months.

The Department of Commerce reported that its index of primary business activity which dropped sharply in week ended March 21 probably will record a corresponding recovery for the week ended March 28. Reconstruction work in the districts affected by floods has gone forward rapidly, the Department said, with operations in most areas restored to a normal basis by the end of month.

Freight car loadings in the second quarter are expected to run about 9.5 per cent above actual loadings reported for the second quarter of last year, according to estimates compiled by the thirteen shippers' regional advisory boards, made public on the first of the month.

Of the 29 groups of commodities for which estimates were made, only three are expected to move in smaller volume than they did in the second quarter of last year and all of them are agricultural products.

Among the groups for which increases in shipment are forecast are: coal and coke, 7.4 per cent; ore and concentrates, 12.2 per cent; petroleum and petroleum products, 5.6 per cent; iron and steel, 16.7 per cent; fertilizers, 3.4 per cent; paper, paper board, and prepared roofing, 13.9 per cent; and chemicals and explosives, 4.0 per cent.

According to the National Fertilizer Association superphosphate production in February, totaling 233,999 tons, was 5.5 per cent less than in February, 1935, making the fourth consecutive month in which production was under the corresponding month of the preceding year. For January and February combined, production was 10.3 per cent under 1935, and 9.4 per cent under 1934. Output of acidulators in the Northern Area was almost as large in February as it was a year ago, but a substantial decline occurred in the South.

As a result of smaller shipments to consumers and in base and mixed goods, total shipments in February were somewhat under last year; shipments to mixers and to other acidulators showed small increases. The decline was particularly large in the northern area, which reported shipments to consumers 38 per cent smaller than a year ago and shipments in base and mixed goods 55 per cent less. There was a 17.5 per cent decrease in shipments to consumers in the first two months of this year compared with the corresponding period of 1935, and a 15.3 per cent decrease in the amount of superphosphate shipped in base and mixed goods.

Trade forecasts indicate an increase in automotive output for the second quarter of about 10 per cent over the first quarter production. April production is not expected to equal that of April, 1935, when 501,814 units were produced in this country and Canada, but a total of close to 470,000 units is held probable for the current month. Comparing the second quarter with the like period of last year, it is improbable that production this year will come up to that of last year.

Consumption of cottonseed oil in February was considerably ahead of what had been expected, reaching a total of 197,185 bbl. which was an increase of 12,000 bbl. over January consumption but suffered in comparison with the 224,376 bbl. for February last year.

Sales of fertilizer in the nine cotton producing states reached a total of 1,234,805 tons in March compared with 1,264,723 tons in March, 1935. For the eight months of the fertilizer season ended March 31, sales amounted to 2,125,229 tons for 1935-1936, 2,224,712 tons for 1934-1935, and 1,985,707 tons for 1933-1934.

Foreign demand for American chemicals and related products continued active in February, the total value of such sales being recorded at $11,651,000, according to Commerce Department's Chemical Division. This compares with export shipments valued at $9,444,000 during the corresponding month of last year, $8,870,000 in February, 1934, and $6,474,000 for February, 1933.

Fertilizer exports increased to a total of 150,000 tons during the month compared with 92,846 tons in February, 1935. In this group phosphate rock shipments increased from 77,000 tons to 105,000 tons; nitrogens from 10,646 tons to 36,326 tons; potash from 1,569 tons to 6,213 tons, statistics show.

Exports of sulphur were also heavy during the month and totaled 51,500 tons, valued at $1,025,921, compared with 25,439 tons, valued at $493,300, in February, 1934.

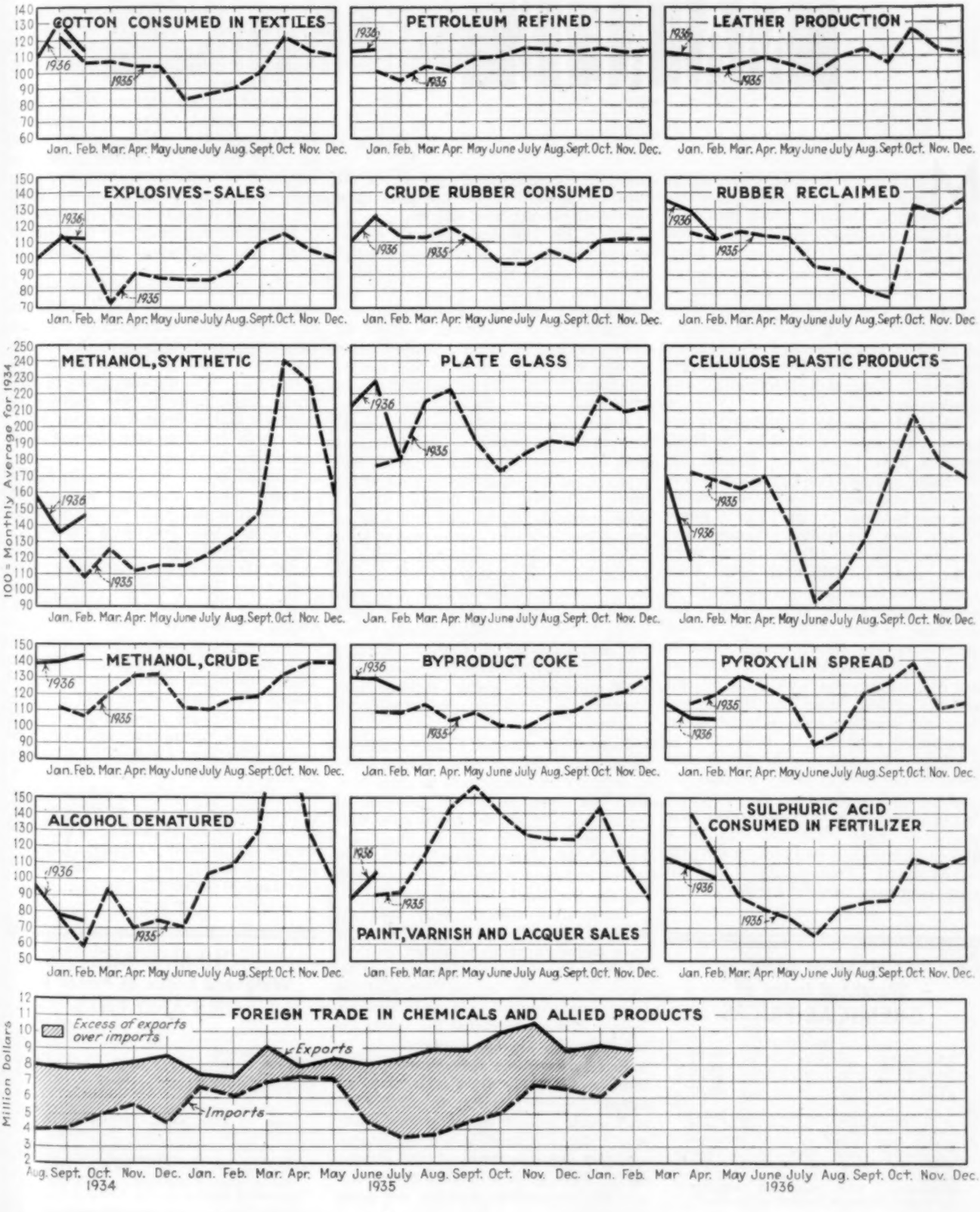
Export demand for American paint products continued active, foreign shipments being valued at $1,396,500 in February compared with $1,136,560 for the corresponding month of last year, the increase being due to heavier shipments of all classes of ready mixed paints, varnishes and lacquers.

Production and Consumption Data for Chemical-Consuming Industries

	Feb. 1936	Feb. 1935	Jan.-Feb. 1936	Jan.-Feb. 1935	Gain Jan.-Feb. 1936 over Jan.-Feb. 1935 Per Cent
Production					
Alcohol, denatured, 1,000 wi.gal.	5,939	4,611	12,146	10,658	13.9
Ammonia,[1] tons	49,734	42,562	102,154	85,349	19.7
Automobiles No.	290,964	335,667	658,216	628,452	4.7
Benzol, 1,000 gal.	7,303	6,200	15,128	12,382	22.2
Glass containers, 1,000 gr.	3,047	2,639	6,161	5,574	10.5
Plate glass, 1,000 sq.ft.	13,857	13,723	31,133	27,088	14.9
Methanol, crude, gal.	494,144	363,781	988,225	750,258	31.7
Methanol, synthetic, gal.	1,540,171	1,126,799	2,959,034	2,429,970	21.7
Pyroxylin spread, 1,000 lb.	3,894	4,444	7,846	8,658	9.4*
Rosin, wood, bbl.	52,693	43,252	104,849	87,741	19.5
Turpentine, wood, bbl.	8,740	6,138	17,782	13,213	34.6
Steel barrels, No.	512,275	404,203	1,049,167	841,645	24.7
Sulphuric acid in fertilizer trade, tons	152,860	154,359	309,738	323,660	4.3*
Rubber reclaimed, tons	10,188	10,072	21,853	20,537	6.4
Consumption					
Cotton, 1,000 bales	517	478	1,108	1,031	7.5
Wool, 1,000 lb.	64,193	51,616	138,101	109,986	25.6
Explosives, 1,000 lb.	28,825	26,019	57,317	55,166	3.9
Sulphuric acid in fertilizer trade, tons	117,864	133,319	243,594	295,977	17.7*

[1]Production at byproduct coke plants, quantity represents ammonium sulphate equivalent of all forms.
*Per cent of decline.

TRENDS OF PRODUCTION AND CONSUMPTION



The MARKETS

MOST important development of the month in the chemical market was the situation brought about by flood conditions in three of the prominent industrial sections of the country. Very few chemical plants were in the affected zones and market developments were of interest not because of interference with chemical production but rather because of the emergency demand which arose for such chemicals as bleaching powder, chlorine, copperas, insecticides and similar materials.

Fears of epidemics following the unsanitary conditions created by the flood, resulted in an immediate demand for bleaching powder and producers responded energetically with the result that spot holdings at plants and in warehouses were practically exhausted and consumers in non-affected areas were called upon to relinquish what they could spare from their private stocks to relieve the situation. What was true for bleaching powder applied with almost equal force to chlorine and chlorine products. Various kinds of insecticides and disinfectants met with a similar call and the general result has been to reduce spot supplies of many chemicals to a vanishing point.

While the conditions in the flooded areas tended to cut down demand for other chemicals because of suspended manufacturing operations, call for stocks in other directions was on a higher scale than it had been in the preceding month. Entering April this improvement was further augmented and business for the second quarter of the year is expected to show a good gain over that for the first quarter.

Prices for chemicals showed an irregular tendency. Solvents continued their downward trend with competitive conditions unsettling values. On the other hand sulphate of ammonia was strongly held with reports of small lot sales at advanced prices. White lead in oil was marked up in price and limited offerings of glycerine brought about higher sales prices for that commodity.

Prices for vegetable oils and animal fats varied according to the selections with the more important products except linseed oil reporting gains and the others selling at lower levels. Arsenic while quotably unchanged has sold at low prices in recent weeks due to keen competition from imported material which has been coming into this country in unusually large volume. One producer announced a reduction of 5c. a lb. in the price of methyl chloride effective April 1. In the coal-tar group a firm situation continues for naphthalene with production going steadily into consumption with no opportunity to amass spot supplies.

Commodity Credit Corporation reports steady sales of naval stores, taken as security for loans made in connection with the crop reduction program of New Deal. In all, the corporation took over some 293,000 bbl. of rosin and 148,500 bbl. of turpentine, which were stored in fifteen different places, including the five chief shipping ports.

Corporation officials deny that the sales of this stock of naval stores can have undue effect upon market, as it is, so they say, no more than the normal carryover supply, in the hands of the Government, instead of in private hands. Indeed it is asserted that the stocks are less than the average carryover.

Prices have been held to the market level as nearly as practicable, it is asserted: "We are trying to market the stuff just as any naval stores dealer would do," declared Milton S. Briggs, assistant administrator of the department. "We wish to disturb the market as little as possible, and we are doing just that."

Bill introduced by Representative Knutson of Minn., providing for increase in tax on imported coconut oil and deflection of the proceeds of that tax from Philippines to U. S. Treasury, is dormant in committee of Ways and Means. Furthermore it is likely to remain dormant for the rest of this session. Same is true of the Shipstead measure before Senate, which is virtually the same bill.

Present tax on coconut oil is three cents a pound. Proposed measures would make the tax five cents. Last year tax resulted in cutting down consumption of imported oil heavily, especially in industry.. Opinion seems fairly general that if tax is raised as proposed, it will force consumers to find substitutes, thus destroying our market for the product.

Chief opponents to use of coconut oil, and so solidly back of Knutson bill, are dairy interests of Knutson's district, but the cotton seed oil people also are in favor of increasing the tax on the imported oils. The manufacturers of high grade soaps however are opposed to proposed tax on ground no other material can be found to take place of coconut oil for their product.

Sales of potash fertilizer salts by the German Potash Syndicate attained an all-time peak last year reaching 1,320,000 metric tons potassium oxide content, compared with the depression low of 847,000 tons in 1932, according to reports from Germany made public by the Commerce Department's Chemical Division. The gain in 1935 was 8 per cent over the preceding year, which in turn was 30 per cent higher than in 1933. Domestic and foreign sales of potash both shared in the 1935 gain, the former increasing about 8 per cent to 930,000 tons, compared with the preceding year, thus for the first time surpassing the 1928 peak of 870,000 tons, and the latter likewise expanded approximately 8 per cent to around 390,000 tons, the report states. The actual weight of exports exceeded 1,050,000 metric tons. World potash consumption increased 10 per cent last year.

CHEM. & MET. Weighted Index of CHEMICAL PRICES

Base = 100 for 1927

This month	86.67
Last month	86.87
April, 1935	87.53
April, 1934	88.93

Through error the weighted index number for March as published last month was placed at 87.15 whereas it should have read 86.87. The February index was 86.93 and the March index was .06 below that for February. The weighted number for April shows a further drop of .20.

CHEM. & MET. Weighted Index of Prices for OILS AND FATS

Base = 100 for 1927

This month	87.01
Last month	85.48
April, 1935	94.47
April, 1934	57.13

Fluctuations in price were numerous on both sides of the market. China wood oil closed the period in a strong position. Linseed oil was lower. Crude cottonseed oil closed fractionally higher. Tallow held a fairly steady position. Glycerine is in small supply and is firmly held.

Current PRICES

The following prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to April 12.

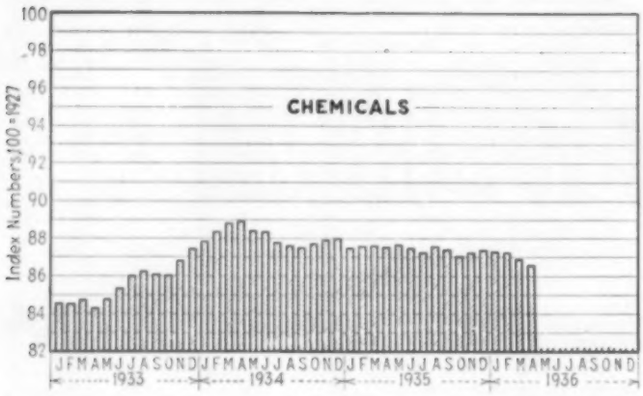
Industrial Chemicals

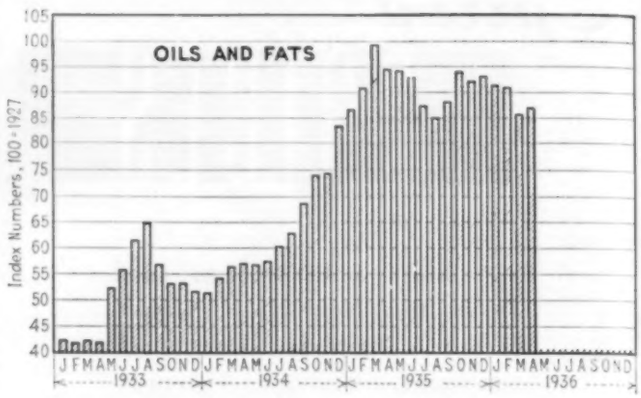
	Current Price	Last Month	Last Year
Acetone, drums, lb.	$0.09½–$0.10	$0.10½–$0.11	$0.12 –$0.12½
Acid, acetic, 28%, bbl., cwt.	2.45 – 2.70	2.45 – 2.70	2.40 – 2.55
Glacial 99%, drums	8.43 – 8.68	8.43 – 8.68	8.25 – 8.50
U. S. P. reagent	10.52 –10.77	10.52 –10.77	10.52 –10.77
Boric, bbl., ton	105.00–115.00	105.00–115.00	95.00 –105.00
Citric, kegs, lb.	.27 – .30	.28 – .31	.28 – .31
Formic, bbl., ton	.11 – .11½	.11 – .11½	.11 – .11½
Gallic, tech., bbl., lb.	.60 – .65	.60 – .65	.60 – .65
Hydrofluoric 30% carb., lb.	.07 – .07½	.07 – .07½	.07 – .07½
Lactic, 44%, tech., light, bbl., lb.	.11½– .12	.11½– .12	.12 – .12½
22%, tech., light, bbl., lb.	.06½– .07	.06½– .07	.06½– .07
Muriatic, 18°, tanks, cwt.	1.00 – 1.10	1.00 – 1.10	1.00 – 1.10
Nitric, 36°, carboys, lb.	.05 – .05¼	.05 – .05¼	.05 – .05¼
Oleum, tanks, wks., ton	18.50 –20.00	18.50 –	18.50 –20.00
Oxalic, crystals, bbl., lb.	.11½– .12½	.11½– .12½	.11½– .12½
Phosphoric, tech., c'bys., lb.	.09 – .10	.09 – .10	.09 – .10
Sulphuric, 60°, tanks, ton	11.00 –11.50	11.00 –11.50	11.00 –11.50
Sulphuric, 66°, tanks, ton	15.50 –	15.50 –	15.50 –
Tannic, tech., bbl., lb.	.23 – .35	.23 – .35	.23 – .35
Tartaric, powd., bbl., lb.	.24 – .25	.24 – .25	.24 – .25
Tungstic, bbl., lb.	1.50 – 1.60	1.50 – 1.60	1.40 – 1.50
Alcohol, Amyl	–	–	–
From Pentane, tanks, lb.	.15 –	.15 –	.15 –
Alcohol, Butyl, tanks, lb.	.09½–	.11 –	.13 –
Alcohol, Ethyl, 190 p'f., bbl., gal.	4.27½–	4.27½–	4.27½–
Denatured, 190 proof			
No. 1 special, dr., gal.	.34 –	.34 –	.36 –
Alum, ammonia, lump, bbl., lb.	.03 – .04	.03 – .04	.03 – .04
Chrome, bbl., lb.	.04½– .05	.04½– .05	.04½– .05
Potash, lump, bbl., lb.	.03½– .04	.03 – .04	.03 – .04
Aluminum sulphate, com., bags cwt.	1.35 – 1.50	1.35 – 1.50	1.35 – 1.50
Iron free, bg., cwt.	2.00 – 2.25	2.00 – 2.25	1.90 – 2.00
Aqua ammonia, 26°, drums, lb.	.02½– .03	.02½– .03	.02½– .03
tanks, lb.	.02½– .02¾	.02½– .02¾	.02½– .02¾
Ammonia, anhydrous, cyl., lb.	.15½– .16	.15½– .16	.15½– .16
tanks, lb.	.04½–	.04½–	.04½–
Ammonium carbonate, powd. tech., casks, lb.	.08 – .12	.08 – .12	.08 – .12
Sulphate, wks., cwt.	1.25 –	1.25 –	1.20 –
Amylacetate tech., tanks, lb.	.12 – .135	.12 – .135	.142–
Antimony Oxide, bbl., lb.	.13½– .14	.13½– .14	.11½– .12
Arsenic, white, powd., bbl., lb.	.03½– .04	.03½– .04	.03½– .04
Red, powd., kegs, lb.	.15½– .16	.15½– .16	.15½– .16
Barium carbonate, bbl., ton	56. 50 –58. 00	56. 50 –58. 00	56. 50 –58. 00
Chloride, bbl., ton	72. 00 –74. 00	72. 00 –74. 00	72. 00 –74. 00
Nitrate, cask, lb.	.08½– .09	.08½– .09	.08½– .09
Blanc fixe, dry, bbl., lb.	.03½– .04	.03½– .04	.03½– .04
Bleaching powder, f.o.b., wks., drums, cwt.	2.00 – 2.10	2.00 – 2.10	1.90 – 2.00
Borax, gran., bags, ton	44.00 –49.00	44.00 –49.00	40.00 –45.00
Bromine, cs., lb.	.36 – .38	.36 – .38	.36 – .38
Calcium acetate, bags	2.10 –	2.10 –	2.00 –
Arsenate, dr., lb.	.06 – .07	.06 – .07	.06 – .07
Carbide drums, lb.	.05 – .06	.05 – .06	.05 – .06
Chloride, fused, dr., del., ton	20.00 –33.00	20.00 –33.00	20.00 –33.00
flake, dr., del., ton	22.00 –35.00	22.00 –35.00	22.00 –35.00
Phosphate, bbl., lb.	.07½– .08	.07½– .08	.07½– .08
Carbon bisulphide, drums, lb.	.05½– .06	.05½– .06	.05½– .06
Tetrachloride drums, lb.	.05½– .08½	.05½– .06	.05½– .06
Chlorine, liquid, tanks, wks., lb.	2.15 –	2.15 –	2.00–
Cylinders	.05½– .06	.05½– .06	.05½– .06
Cobalt oxide, cans, lb.	1.29 – 1.35	1.29 – 1.35	1.25 – 1.35
Copperas, bgs., f.o.b., wks., ton	15.00 –16.00	15.00 –16.00	14.00 –15.00
Copper carbonate, bbl., lb.	.08½– .16	.08½– .16	.08½– .16
Cyanide, tech., bbl., lb.	.37 – .38	.37 – .38	.37 – .38
Sulphate, bbl., cwt.	3.85 – 4.00	3.85 – 4.00	3.85 – 4.00
Cream of tartar, bbl., lb.	.16½– .17	.16½– .17	.16½– .17
Diethylene glycol, dr., lb.	.16½– .20½	.16½– .20½	.16½– .20½
Epsom salt, dom., tech., bbl., cwt.	1.80 – 2.00	1.80 – 2.00	2.10 – 2.15
Imp., tech., bags, cwt.	2.00 – 2.10	2.00 – 2.10	2.00 – 2.10
Ethyl acetate, drums, lb.	.07½–	.07½–	.08½–
Formaldehyde, 40%, bbl., lb.	.06 – .07	.06 – .07	.06 – .07
Furfural, dr., contact, lb.	.10 – .17½	.10 – .17½	.10 – .17½
Fusel oil, ref. drums, lb.	.16 – .18	.16 – .18	.16 – .18
Glaubers salt, bags, cwt.	.85 – 1.00	.85 – 1.00	1.00 – 1.10
Glycerine, c.p., drums, extra, lb.	.14½– .15	.14 – .14½	.14 – .14½
Lead:			
White, basic carbonate, dry casks, lb.	.06½–	.06½–	.06½–
White, basic sulphate, sck., lb.	.06 –	.06 –	.06 –
Red, dry, sck., lb.	.07 –	.07 –	.06½–
Lead acetate, white crys., bbl., lb.	.10½– .11	.10½– .11	.10½– .11
Lead arsenate, powd., bbl., lb.	.09 – .10	.09 – .10	.09 – .10
Lime, chem., bulk, ton	8.50 –	8.50 –	8.50 –
Litharge, pwd., csk., lb.	.06 –	.06 –	.05 –
Lithophone, bags, lb.	.04½– .05	.04½– .05	.04½– .05
Magnesium carb., tech., bags, lb.	.06 – .06½	.06 – .06½	.06 – .06½
Methanol, 95%, tanks, gal.	.33 –	.33 –	.33 –
97%, tanks, gal.	.34 –	.34 –	.34 –
Synthetic, tanks, gal.	.35½–	.35½–	.35½–
Nickel salt, double, bbl., lb.	13 – .13½	.13 – .13½	.12½– .13
Orange mineral, csk., lb.	.10 –	.10 –	.09 –
Phosphorus, red, cases, lb.	.44 – .45	.44 – .45	.44 – .45
Yellow, cases, lb.	.28 – .32	.28 – .32	.28 – .32
Potassium bichromate, casks, lb.	.08½– .09	.08½– .09	.07½– .08½
Carbonate, 80-85%, calc. csk., lb.	.07 – .07½	.07 – .07½	.07 – .07½
Chlorate, powd., lb.	.08 – .08½	.08 – .08½	.08½– .09
Hydroxide(c'stic potash) dr., lb.	.06½– .06½	.06½– .06½	.06½– .06½
Muriate, 80% bgs., ton	23.00 –	23.00 –	22.00 –
Nitrate, bbl., lb.	.05½– .06	.05½– .06	.05½– .06
Permanganate, drums, lb.	.18½– .19	.18½– .19	.18½– .19
Prussiate, yellow, casks, lb.	.18 – .19	.18 – .19	.18 – .19
Sal ammoniac, white, casks, lb.	.04½– .05	.04½– .05	.04½– .05
Salsoda, bbl., cwt.	1.00 – 1.05	1.00 – 1.05	1.00 – 1.05
Salt cake, bulk, ton	13.00 –15.00	13.00 –15.00	13.00 –15.00
Soda ash, light, 58%, bags, contract, cwt.	1.23 –	1.23 –	1.23 –
Dense, bags, cwt.	1.25 –	1.25 –	1.25 –
Soda, caustic, 76%, solid, drums, contract, cwt.	2.60 – 3.00	2.60 – 3.00	2.60 – 3.00
Acetate, works, bbl., lb.	.04½– .05	.04½– .05	.04½– .05
Bicarbonate, bbl., cwt.	1.85 – 2.00	1.85 – 2.00	1.85 – 2.00
Bichromate, casks, lb.	.06½– .07	.06½– .07	.05½– .06½
Bisulphate, bulk, ton	15.00 –16.00	15.00 –16.00	14.00 –16.00
Bisulphite, bbl., lb.	.03½– .04	.03½– .04	.03 – .04
Chlorate, kegs, lb.	.06½– .06½	.06½– .06½	.06½– .06½
Chloride, tech., ton	12.00 –14.75	12.00 –14.75	12.00 –14.75
Cyanide, cases, dom., lb.	.15½– .16	.15½– .16	.15½– .16
Fluoride, bbl., lb.	.07½– .08	.07½– .08	.07½– .08
Hyposulphite, bbl., lb.	2.40 – 2.50	2.40 – 2.50	2.40 – 2.50
Metasilicate, bbl., cwt.	2.90 – 3.00	2.90 – 3.00	3.25 – 3.40
Nitrate, bags, cwt.	1.325–	1.325–	1.275–
Nitrite, casks, lb.	.07½– .08	.07½– .08	.07½– .08
Phosphate, dibasic, bbl., lb.	.022– .023	.022– .023	.022– .024
Prussiate, yel. drums, lb.	.11½– .12	.11½– .12	.11½– .12
Silicate (40° dr.) wks., cwt.	.80 – .85	.80 – .85	.80 – .85
Sulphide, fused, 60-62%, dr., lb.	.02½– .03½	.02½– .03	.02½– .03
Sulphite, cyrs., bbl., lb.	.02½– .02½	.02½– .02½	.02½– .02½
Sulphur, crude at mine, bulk, ton	18.00 –	18.00 –	18.00 –
Chloride, dr., lb.	.03½– .04	.03½– .04	.03½– .04
Dioxide, cyl, lb.	.06½– .08	.06½– .08	.07 – .07½
Flour, bag, cwt.	1.60 – 3.00	1.60 – 3.00	1.60 – 3.00
Tin Oxide, bbl., lb.	.51 –	.51 –	.51 –
Crystals, bbl., lb.	.37½–	.37 –	.37½–
Zinc chloride, gran., bbl., lb.	.05 – .06	.05 – .06	.05 – .06
Carbonate, bbl., lb.	.09 – .11	.09 – .11	.09½– .11
Cyanide, dr., lb.	.36 – .38	.36 – .38	.36 – .38
Dust, bbl., lb.	.069– .07	.069– .07	.059– .07
Zinc oxide, lead free, bag, lb.	.05 –	.05 –	.05½–
5% lead sulphate, bags, lb.	.04½–	.04½–	.05½–
Sulphate, bbl., cwt.	2.65 – 3.00	2.65 – 3.00	2.75 – 3.00

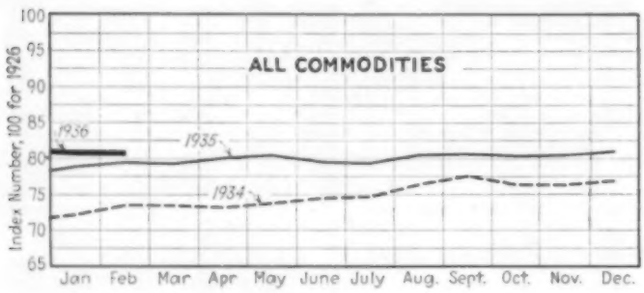
Oils and Fats

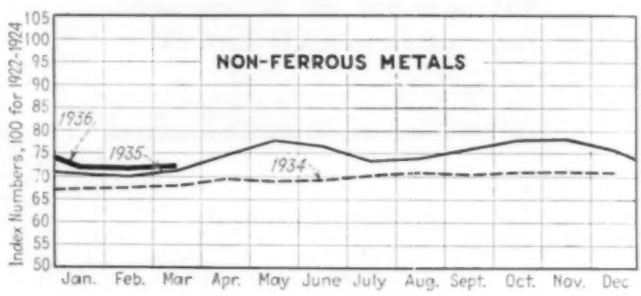
	Current Price	Last Month	Last Year
Castor oil, No. 3, bbl., lb.	$0.10 –$0.11	$0.10 –$0.11	$0.09½–$0.10
Chinawood oil, bbl., lb.	.19 –	.16½–	.15 –
Coconut oil, Ceylon, tanks, N. Y. lb.	.04½–	.04½–	.05½–
Corn oil crude, tanks, (f.o.b mill), lb.	.08½–	.08½–	.09½–
Cottonseed oil, crude (f.o.b. mill), tanks, lb.	.08½–	.08½–	.09½–
Linseed oil, raw car lots, bbl., lb.	.096–	.098–	.095–
Palm, casks, lb.	.04½–	.04½–	.05½–
Palm kernel, bbl., lb.	.05½–	.05½–	nom.
Peanut oil, crude, tanks (mill), lb.	.08½–	.08½–	.09½–
Rapeseed oil, refined, bbl., gal.	.53 –	.52 –	.46 –
Soya bean, tank, lb.	.08 –	.08 –	.10 –
Sulphur (olive foots), bbl., lb.	.08 –	.08½–	.08½–
Cod, Newfoundland, bbl., gal.	.40 –	.40 –	.35 –
Menhaden, light pressed, bbl., lb	.066–	.069–	.069–
Crude, tanks (f.o.b. factory), gal.	.34 –	.36 –	.35 –
Grease, yellow, loose, lb.	.04½–	.04½–	.06½–
Oleo stearine, lb.	.08 –	.08½–	.10½–
Red oil, distilled, d.p. bbl., lb.	.09½–	.09½–	.09½–
Tallow, extra, loose, lb.	.05½–	.05½–	.06½–

CHEM. & MET.'S WEIGHTED PRICE INDEXES









Coal-Tar Products

	Current Price	Last Month	Last Year
Alpha-naphthol, crude, bbl., lb.	$0.60 –$0.65	$0.60 –$0.65	$0.60 –$0.62
Refined, bbl., lb.	.80 – .85	.80 – .85	.80 – .85
Alpha-naphthylamine, bbl., lb.	.32 – .34	.32 – .34	.32 – .34
Aniline oil, drums, extra, lb.	.14½– .15	.14½– .15	.14½– .15
Aniline salts, bbl., lb.	.24 – .25	.24 – .25	.24 – .52
Benzaldehyde, U.S.P., dr., lb.	1.10 – 1.25	1.10 – 1.25	1.10 – 1.25
Benzidine base, bbl, lb.	.65 – .67	.65 – .67	.65 – .67
Benzoic acid, U.S.P., kgs., lb.	.48 – .52	.48 – .52	.48 – .52
Benzyl chloride, tech., dr., lb.	.30 – .35	.30 – .35	.30 – .35
Benzol, 90%, tanks, works, gal.	.18 – .20	.18 – .20	.15 – .16
Beta-naphthol, tech., drums, lb.	.24 – .27	.24 – .27	.22 – .24
Cresol, U.S.P., dr., lb.	.11 – .11½	.11 – .11½	.11 – .11½
Cresylic acid, 99%, dr., wks., gal.	.58 – .60	.58 – .60	.50 – .51
Diethylaniline, dr., lb.	.55 – .58	.55 – .58	.55 – .58
Dinitrophenol, bbl., lb.	.29 – .30	.29 – .30	.29 – .30
Dinitrotoluen, bbl., lb.	.16 – .17	.16 – .17	.16 – .17
Dip oil, 25%, dr., gal.	.23 – .25	.23 – .25	.23 – .25
Diphenylamine, bbl., lb.	.38 – .40	.38 – .40	.38 – .40
H-acid, bbl., lb.	.65 – .70	.65 – .70	.65 – .70
Naphthalene, flake, bbl., lb.	.07 – .07½	.07 – .07½	.05½– .06
Nitrobensene, dr., lb.	.08½– .09	.08½– .09	.08½– .10
Para-nitraniline, bbl., lb.	.51 – .55	.51 – .55	.51 – .55
Phenol, U.S.P., drums, lb.	.14½– .15	.14½– .15	.14½– .15
Picric acid, bbl., lb.	.30 – .40	.30 – .40	.30 – .40
Pyridine, dr., gal.	1.10 – 1.15	1.10 – 1.15	1.10 – 1.15
Resorcinal, tech., kegs, lb.	.65 – .70	.65 – .70	.65 – .70
Salicylic acid, tech., bbl., lb.	.40 – .42	.40 – .42	.40 – .42
Solvent naphtha, w.w., tanks, gal	.26 –	.26 –	.26 –
Tolidine, bbl., lb.	.88 – .90	.88 – .90	.88 – .90
Toluene, tanks, works, gal.	.30 –	.30 –	.30 –
Xylene, com., tanks, gal.	.30 –	.30 –	.30 –

Miscellaneous

	Current Price	Last Month	Last Year
Barytes, grid., white, bbl., ton.	$22.00–$25.00	$22.00–$25.00	$22.00–$25.00
Casein, tech., bbl., lb.	.14½– .16	.14½– .15	.12½– .13
China clay, dom., f.o.b. mine, ton	8.00 –20.00	8.00 –20.00	8.00 –20.00
Dry colors:			
Carbon gas, black (wks.), lb.	.04 – .20	.04 – .20	.04 – .20
Prussian blue, bbl., lb.	.37 – .38	.37 – .38	.35½– .37
Ultramarine blue, bbl., lb.	.10 – .26	.10 – .26	.06 – .32
Chrome green, bbl., lb.	.26 – .27	.26 – .27	.26 – .27
Carmine red, tins, lb.	4.00 – 4.40	4.00 – 4.40	4.00 – 4.40
Para toner, lb.	.80 – .85	.80 – .85	.80 – .85
Vermilion, English, bbl., lb.	1.59 – 1.60	1.59 – 1.60	1.56 – 1.60
Chrome yellow, C. P., bbl., lb.	.12 – .14	.12 – .14	.15 – .15½
Feldspar, No. 1 (f.o.b. N.C.), ton.	6.50 – 7.50	6.50 – 7.50	6.50 – 7.50
Graphite, Ceylon, lump, bbl., lb.	.07 – .08½	.07 – .08½	.07 – .08½
Gum copal Congo, bags, lb.	.09 – .10	.09 – .10	.09 – .10
Manila, bags, lb.	.09 – .10	.09 – .10	.16 – .17
Damar, Batavia, cases, lb.	.15½– .16	.15½– .16	.16 – .16½
Kauri No. 1 cases, lb.	.20 – .25	.20 – .25	.20 – .25
Kieselguhr (f.o.b. N. Y.), ton.	50.00 –55.00	50.00 –55.00	50.00 –55.00
Magnesite, calc, ton.	50.00 –	50.00 –	40.00 –
Pumice stone, lump, bbl., lb.	.05 – .07	.05 – .08	.05 – .07
Imported, casks, lb.	.03 – .40	.03 – .40	.03 – .35
Rosin, H., bbl.	5.70 –	5.75 –	5.65 –
Turpentine, gal.	.43 –	.45½–	.52½–
Shellac, orange, fine, bags, lb.	.25 –	.26 –	.27 –
Bleached, bonedry, bags, lb.	.19 –	.24½–	.21 –
T. N. bags, lb.	.14½–	.14 –	.14 –
Soapstone (f.o.b. Vt.), bags, ton.	10.00 –12.00	10.00 –12.00	10.00 –12.00
Talc, 200 mesh (f.o.b. Vt.), ton.	8.00 – 8.50	8.00 – 8.50	8.00 – 8.50
300 mesh (f.o.b. Ga.), ton.	7.50 –10.00	7.50 –10.00	7.50 –11.00
225 mesh (f.o.b. N. Y.), ton.	13.75 –	13.75 –	13.75 –

INDUSTRIAL NOTES

VANADIUM CORPORATION OF AMERICA has moved its general offices to 420 Lexington Ave., New York.

WILSON & BENNETT MFG. CO., Chicago, has promoted John P. Moran to Chicago sales manager and has appointed Grant S. Smith manager of its food container drums.

FOOTE BROS. GEAR AND MACHINE CORP., Chicago, has taken over all activities and assets of Foote Bros. Gear and Machine Co.

HILL DIESEL ENGINE CO., Lansing, Mich., has appointed James M. Degnan general sales manager.

OLIVER UNITED FILTERS INC., New York, has appointed T. D. Boyd, Mexico City, as representative in the cane sugar industry of Mexico.

PORCELAIN ENAMEL & MFG. CO., Baltimore, has appointed Harry Ingersoll as Pacific Coast representative with headquarters at 4514 S. Van Ness Ave., Los Angeles.

THE U. S. STONEWARE CO., has moved its general offices to 60 East 42nd St., New York.

LINK-BELT CO., Chicago, has elected Alfred Kauffmann president to succeed George P. Torrence, resigned.

STEIN EQUIPMENT CORP., 426 Broome St., New York has been formed by Jerome D. Stein, formerly secretary-treasurer of Stein-Brill Corp.

DETROIT REX PRODUCTS CO., Detroit, Mich., has moved its eastern sales office to 130 West 42d St., New York.

BLACKMER ROTARY PUMP CO., Grand Rapids, Mich., has elected Albert B. Hoffman president and general manager.

G. H. WOOD & CO., LTD., Toronto, Canada, is occupying temporary quarters at 1244 Dufferin St., following a fire which gutted its plant and warehouse.

New CONSTRUCTION

Where Plants Are Being Built in Process Industries

	Current Projects		Cumulative 1936	
	Proposed Work	Contracts	Proposed Work	Contracts
New England	.....	$75,000	$349,000	$212,000
Middle Atlantic	$150,000	768,000	1,221,000	1,840,000
South	270,000	387,000	687,000	5,326,000
Middle West	237,000	350,000	2,419,000	3,871,000
West of Mississippi	30,000	7,501,000	5,508,000	4,674,000
Far West	100,000	1,500,000	168,000	4,862,000
Canada	1,500,000	37,000	10,768,000	224,000
Total	$2,287,000	$10,618,000	$21,120,000	$21,009,000

PROPOSED WORK
BIDS ASKED

Chemical Spray Plant — California Spray Chemical Co., c/o Stone & Webster, Engrs., Russ Bldg., San Francisco, Calif., plans to construct a chemical spray plant. Estimated cost $100,000.

Distillery — Frieburg & Workum Distillery, c/o John L. Bennett, Decatur, Ill., plans to recondition its distillery at Lynchburg, O. Estimated cost $100,000.

Distillery — C. W. Gale, Salisbury, Md., is having plans prepared for two 1-story and one 2-story distillery plant buildings. Estimated cost $75,000.

Factory—International Bitumen Co., Ltd., Edmonton, Alta., Can., plans to construct a factory to extract petroleum and other byproducts from tar-sand deposits at Fort McMurray, Alta. Estimated cost $1,500,000.

Fertilizer Factory—Swift & Co., Union Stock Yards, Chicago, Ill., will soon award the contract for a 1 story, 100x150 ft. addition to fertilizer factory at Milwaukee, Wis. H. C. Watts, Construction Dept., Chicago, Engr.

Glass Factory—Know Glass & Bottle Mfg. Co., Fannin, Miss., contemplates repairs and alterations to its factory here. Estimated cost $40,000.

Glass Factory—Paul G. Sullivan, Attorney, First Natl. Bldg., Pittsburgh, Pa., acting for a group connected with the Continental Glass Mfg. Co., The Hague, Holland, has purchased the glass manufacturing plant formerly occupied by the Durant Motor Car Co., at Durant City, near Kane, Pa. The Company is making surveys for rehabilitating and improving same for the manufacture of plate and safety glass and special glass products.

Laboratory—U. S. Department of Agriculture, Washington, D. C., plans to construct a combination laboratory and office building in Charleston Co., S. C. Estimated cost $30,000.

Leather Factory—Ohio Leather Co., Girard St., Youngstown, O., plans improvements to its plant and equipment at Youngstown and other locations. Owner will finance from part of proceeds of bond issue. Estimated cost $100,000.

Refinery—Shoreline Refining Co., Shreveport, La., plans to install a cracking unit at its refinery at Lewis, north of Shreveport. Estimated cost $200,000.

Laboratory Equipment — Board of Public Service, B. L. Brown, Pres., 304 City Hall, St. Louis, Mo., will receive bids until April 21 for installing laboratory equipment in various buildings at Homer G. Phillips City Hospital. W. C. E. Becker, 301 City Hall, Engr. Estimated cost $30,000.

Equipment—Sloan & Zook Co., P. Tinkler, Gen'l. Supt., 101 Main St., Bradford, Pa., is in the market for air compressors, pumping units, gas engines, electrical equipment and other equipment for $750,000 pressure plant project for recovery of crude oil in Venango County, Pa.

CONTRACTS AWARDED

Chemical Factory—Dewey & Almy Chemical Co., 235 Harvey St., Cambridge, Mass., has awarded the contract for a factory and office building to L. C. Blake, 50 Dyer Ave., Milton, Mass. Estimated cost $75,000.

Chemical Factory — Monsanto Chemical Co., 1700 South 2nd St., St. Louis, Mo., awarded contract for 3 story, 61x120 ft. special products building for chemical plant to Fruin-Colnon Contracting Co., 502 Merchants-Laclede Bldg., St. Louis.

Chemical Factory — Niacet Chemical Corp., Pine Ave. and 47th St., Niagara Falls, N. Y., has awarded the contract for the construction of a factory building to Laur & Mack Contracting Co., 1400 College Ave., Niagara Falls.

Chemical Plant—Southern Chemical Corp., J. L. Crist, Pres., P. O. Box 1045, Charlotte, N. C., will construct a large manufacturing plant on the Mecklenburg Co. side of Catawba River at Mt. Holly, N. C. Work will be done by day labor. L. G. Atkins, Supt. and Engr. Estimated cost $100,000.

Chemical Plant—Vick Chemical Co., Greensboro, N. C., awarded contract for 2 story brick addition to chemical plant and reconditioning and altering laboratory to George W. Kane, Greensboro. Estimated cost $37,000.

Coke Plant—Republic Steel Corp., R. J. Wysor, Vice Pres. and Gen. Mgr., Republic Bldg., Cleveland, O., plans improvements to its coke plant, open hearths, tube mill, etc., at Youngstown, O. Owners will buy materials from subsidiary companies and do work by direct labor. Estimated cost $200,000.

Cyanamid Factory—American Cyanamid Co., 30 Rockefeller Plaza, New York, N. Y., has acquired 4,500 acres of phosphate property southwest of Fort Meade, Fla., and will construct a factory. Work consists of removing mining, loading, crushing, washing and drying works from exhausted to fresh desposits. All work will be done by day labor. H. L. Mead, Brewster, Fla., Engr. in charge. Estimated cost $250,000.

Factory — Carborundum Co., Buffalo Ave., Niagara Falls, N. Y., awarded contract for Factory Building 36-A, to Wright & Kremers, Inc., Main St. and Pine Ave., Niagara Falls.

Factory—Schulte Pulverizer Corp., Clyde St., Buffalo, N. Y., has awarded the contract for a factory on Kensington Ave., to Walter W. Grupp, 1170 Jefferson Ave., Buffalo.

Glass Factory — Owens-Illinois Glass Co., Macedonia Ave. at 9th St., Muncie, Ind., awarded contract for plant for the manufacture of insulex glass blocks and addition to Plant No. 1, including glass furnace, ovens and storage space, to Simplex Engineering Co., Washington, Pa. Estimated cost including machinery $35,000.

Laboratory — University of New Mexico, Albuquerque, N. M., awarded contract for 1 story Health Laboratory to K. L. House, Albuquerque. Estimated cost $57,000.

Leather Factory—Davis Leather Co., Ltd., 23 Huron St., E., Newmarket, Ont., Can., has awarded the contract for an addition to its factory to Richardson Construction Co., Ltd., 10 Adelaide St., E., Toronto. Estimated cost $37,000.

Lime Kiln—Chemical Lime Co., Thomas M. Brown, Pres., Bellefonte, Pa., will construct a modern lime kiln and also open up new limestone mine on property in Buffalo Run Valley. Company received loan of $500,000 from Reconstruction Finance Corporation to make improvements. Work will be done by day labor and separate contracts.

Petroleum Products Plant—Petroleum Chemical Co., Detroit, Mich., and care of G. J. Wagner & Co., Engrs., Grand Rapids, Mich., has awarded the contract for the construction of a petroleum products plant at Grand Haven to Hurley Bros., Tulsa, Okla. Estimated cost $300,000.

Paper Mill—Champion Paper & Fibre Co Canton, N. C., awarded contract constructing 150 ton kraft pulp mill on Houston Ship Channel at Pasadena, Tex., to Morton C. Tuttle Co., 31 St. James St., Boston, Mass. Estimated cost $3,000,000.

Pulp and Paper Mill—Crossett Lumber Co., 80 East Jackson Blvd., Chicago, Ill., has awarded the contract for the construction of a kraft pulp and paper mill at Crossett, Ark., to Rust Engineering Co., Clark Bldg., Pittsburgh, Pa. Estimated cost $4,000,000.

Research Laboratory—Shell Petroleum Co., c/o A. T. Scovil Co., Archts., Houston, Tex., awarded contract for research laboratory at Bellaire Blvd. and Edloe St., Houston, to P. F. Eller, First Natl. Bank Bldg., Houston. Estimated cost $70,000.

Research Plant—Moore Research & Service Co., Inc., United Office Bldg., Niagara Falls, N. Y., awarded contract for addition to plant on Highland Ave., to Wright & Kremers, Inc., Main St. and Pine Ave., Niagara Falls. Estimated cost will exceed $37,000.

Soap Factory—Procter & Gamble Co., Port Ivory, Staten Island, N. Y., will construct an addition to its factory here. Separate contracts have been awarded for the work. Estimated cost $40,000.

Sugar Factory—Spreckels Sugar Co., 2 Pine St., San Francisco, Calif., will construct a sugar refinery in Yolo Co., Woodland, Calif. Work will be done by separate contracts. K. A. Miserole, c/o Company, Engr. Estimated cost $1,500,000.

Tin Foil Factory—Johnston Tin Foil & Metal Co., 6008 South Bway., St. Louis, Mo., awarded contract for 2 story, 102x117 ft. tin foil factory to J. E. Stauder, 5405 South Bway., St. Louis.

Warehouse—Owens-Illinois Glass Co., Alton, Ill., awarded contract for addition to warehouse at Gas City, Ind., to Austin Co., 510 North Dearborn St., Chicago, Ill. Estimated cost $75,000.

Warehouse—Trenton Valley Distillers, Trenton, Mich., awarded contract for Warehouse No. 5 to Bennage & McKinstrie, 4612 Woodward Ave., Detroit. Estimated cost $40,000.

Warehouse—Wight Distilling Co., Baltimore, Md., awarded contract constructing warehouse at Lorelei, Md., to Engineering Contracting Co., North and Linden Aves., Baltimore. Estimated cost $80,000.

CONSUMPTION OF ANIMAL AND VEGETABLE FATS AND OILS INCREASED LAST YEAR

CONSUMPTION of primary animal and vegetable fats and oils in manufacturing establishments in 1935 is reported by the Bureau of the Census at 4,494,287 thousand pounds. This compares with a total of 4,028,003 thousand pounds for 1934. Hence factory consumption of these commodities increased more than 11.5 per cent last year as compared with the preceding year.

Data for oleo stock were not collected, hence the secondary products, edible animal stearin and oleo oil are shown in the accompanying tabulation. Oils subjected to the process of hydrogenation or other treatment for special uses were reported as consumed in the products for which intended, for example, oils treated for soap manufacture were entered in the column headed soap, etc.

Of the total factory consumption of 4,028,003 thousand pounds in 1934, 1,721,340 thousand pounds were used in the manufacture of compounds and vegetable shortenings, oleomargarine, and other edible products, or a total of 42.7 per cent. In 1935, the amount so used was 2,172,757 thousand pounds or 48.3 per cent of these products consumed in manufacture.

In view of reports to the effect that the soap trade showed a slight increase in output last year, the amount of oils and fats reported as consumed in that industry was disappointing, the total being 1,474,415 thousand pounds for 1934 and 1,312,690 thousand pounds for 1935 or a decline of almost 11 per cent. Sharp declines were credited in soap consumption of cottonseed, coconut, and palm oils with a marked drop also in consumption of greases.

Paint and varnish consumption of oils and fats increased from 329,894 thousand pounds in 1934 to 404,705 thousand pounds in 1935 or a gain of 22.6 per cent for the latter year, which coincides very closely with the percentage gain for sales of paint and varnish. Comparative figures for some of the more important paint-making oils for 1935 and 1934 respectively were: soy bean, 13,003 and 10,451; linseed oil, 230,146 and 205,743; china wood oil, 98,435 and 88,184; perilla oil, 27,164 and 9,898; fish oils, 28,951 and 11,654, all these figures being expressed in terms of thousands of pounds.

Use of oils in the production of linoleum and oilcloth likewise was larger last year than it was in 1934, the totals being 81,031 thousand pounds and 67,811 thousand pounds respectively, or a gain of 19.5 per cent for 1935. The high price which prevailed for China wood oil evidently cut down demand from these industries as linoleum and oilcloth manufacturers used but 10,391 thousand pounds whereas 1934 consumption accounted for 12,854 thousand pounds.

Linseed ranks first among the oils taken by the linoleum and oilcloth trade, in fact it supplied more than one-half of the grand total used last year with 41,809 thousand pounds as the reported figure with 32,108 thousand pounds for 1934. Fish oils hold second place, the figures being 13,865 thousand pounds for 1935 and 13,282 thousand pounds for 1934. Next in rank is China wood oil despite its loss in prestige last year. Perilla oil made rapid strides during the past year, its consumption advancing from the 1934 figure of 4,481 thousand pounds to 9,650 thousand pounds, thus registering a gain of more than 115 per cent. Soy bean oil also was in better demand last year so far as the linoleum and oilcloth trade is concerned with consumption figures at 4,816 thousand pounds and 2,843 thousand pounds for 1935 and 1934 respectively.

Based on consumption of oils, the printing ink trade last year was up 15.8 per cent over the preceding year. Again linseed oil stands out as it accounts for nearly 80 per cent of the oils used by ink makers. China wood oil was used to the extent of 2,013 thousand pounds last year as compared with 1,660 thousand pounds in 1934. Data for perilla oil give consumption in 1934 as 582,000 pounds with a rise to 828,000 pounds in 1935 and in the same period fish oil consumption rose from 103,000 pounds to 354,000 pounds, all these figures referring to printing ink consumption.

From the standpoint of production, the most important development in vegetable oils last year was the sharp increase in domestic output of soy bean oil. The home crop of beans was 39,637,000 bushels and oil production was 104,966,204 pounds, nearly three times that of 1934. With a small Manchurian bean crop, European oil crushing centers bought heavily in this country with an estimate that such purchases amounted to over 1,500,000 bushels last October, November, and December.

Factory Consumption of Animal and Vegetable Fats and Oils, by Classes of Products, Calendar Year 1935

(Quantities in thousands of pounds)

KIND	TOTAL	Compounds and Vegetable Shortenings	Oleomargarine	Other Edible Products	Soap	Paint and Varnish	Linoleum and Oilcloth	Printing Inks	Miscellaneous Products	Loss including Foots
Total	4,494,287	1,543,461	306,275	323,021	1,312,690	404,705	81,031	18,000	288,688	216,416
Cottonseed oil	1,333,739	985,798	99,505	138,580	1,857	36	.....	13	3,978	103,972
Peanut oil	109,378	90,900	4,358	3,602	754	.....	.....	.....	154	9,610
Coconut oil	582,097	44,034	174,314	87,060	229,711	379	.....	2	3,525	43,072
Corn oil	56,121	2,815	32	36,122	2,828	329	.....	.....	3,786	10,209
Soybean oil	91,166	52,452	1,740	9,421	2,549	13,003	4,816	52	1,665	5,468
Olive oil, edible	2,432	.....	.....	2,213	33	.....	.....	.....	186	.....
Olive oil, inedible	10,703	.....	.....	.....	1,690	.....	.....	.....	9,013	.....
Sulphur oil or olive foots	31,860	.....	.....	.....	31,507	.....	.....	.....	353	.....
Palm-kernel oil	57,025	825	425	14,895	37,173	.....	.....	.....	46	3,661
Rapeseed oil	35,802	15,575	.....	460	8,001	168	23	1	10,909	665
Linseed oil	291,684	57	.....	.....	1,196	230,146	41,809	14,266	4,205	5
China wood oil	114,287	.....	.....	.....	.....	98,435	10,391	2,013	3,448	.....
Perilla oil	41,609	55	.....	.....	16	27,164	9,650	828	3,894	2
Castor Oil	25,762	.....	.....	.....	1,056	3,480	477	101	20,648	.....
Palm oil	251,393	114,362	3	3,414	87,311	1	.....	1	*17,109	29,192
Sesame oil	54,252	34,967	77	14,605	749	.....	.....	.....	58	3,796
Sunflower oil	12,402	10,896	100	910	103	310	.....	.....	.....	83
Other vegetable oils	29,680	12,839	**1,878	2,693	4,762	1,929	.....	.....	3,697	1,832
Lard	9,429	2,252	3,005	3,903	1	.....	.....	4	203	61
Edible animal stearin	34,161	27,026	2,612	3,901	338	.....	.....	.....	284	.....
Oleo oil	18,620	126	18,226	86	93	.....	.....	.....	89	.....
Tallow, edible	124,882	120,384	.....	1,156	1,431	.....	.....	2	1,655	254
Tallow, inedible	718,357	.....	.....	.....	663,002	106	.....	9	54,804	436
Grease	200,222	.....	.....	.....	98,086	77	.....	349	101,159	551
Neat's-foot oil	6,626	.....	.....	.....	33	157	.....	1	6,216	219
Marine animal oils	30,963	427	.....	.....	28,440	34	.....	4	1,983	75
Fish oils	219,635	27,671	.....	.....	109,970	28,951	13,865	354	35,621	3,203

*Includes 14,594 thousand pounds reported by the tin and terne plate industry. **Includes 1,838 thousand pounds babassu oil.